Part I, **D R A F T**

ENVIRONMENTAL IMPACT REPORT

LARKSPUR FERRY TERMINAL

Larkspur, California

Golden Gate Bridge, Highway
and Transportation District

July 1973

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EXECUTIVE SUMMARY

The Golden Gate Bridge, Highway and Transportation District plans to develop a ferry terminal facility at Larkspur, California, at a site east of Highway 101 along Sir Francis Drake Boulevard.

The project involves developing terminal facilities for three ferries, in addition to dredging an approach channel along Corte Madera Creek and a turning basin at the confluence of the Hutchinson Quarry Barge Channel and Corte Madera Creek.

The purpose of the project is to provide an integrated bus-ferry system to alleviate peak hour traffic congestion on Highway 101 and the Golden Gate Bridge. Daily patronage is forecast to be 3,200 people in 1975, resulting in a decrease of about 1,600 cars daily on the Golden Gate Bridge.

The major adverse environmental impact of this project is the removal of 83 acres of bottom sediments, marsh and mud flat by dredging approximately 1,300,000 cubic yards of sediments. Other adverse impacts include potential wave action on marsh areas, slight increases in noise levels, increased surface runoff from the area, and some local traffic congestion.

Beneficial impacts include the removal of 1,600 cars daily from Highway 101 and Golden Gate Bridge, and improved flushing of Corte Madera Creek and the Hutchinson Barge Channel.

San Quentin Village and a site north of the San Rafael Bridge have been considered as alternate sites. Neither site would have the patronage expected at the Larkspur site nor offer the flexible bus-ferry commute system which the Larkspur site affords. Virtually

all of San Quentin Village would be removed to provide parking. However, selection of either of the alternate sites for the project would require less dredging.

After weighing the various adverse and beneficial effects of constructing the project at each of the sites under consideration, the Larkspur site would appear to be the preferred one.

Mitigation measures which have been considered in the project design include seismic effects, channel alignments which utilize the natural water course, and landscaping. To offset the losses caused by dredging, restoration of a marsh area using spoils from the project is proposed. Provisions for public access include an educational center, pedestrial and bicycle paths, and fishing facilities.

A. DESCRIPTION OF PROJECT (Section 15141)

1. Project Location

The site for the proposed ferry terminal is a parcel of approximately 25 acres located east of the intersection of Highway 101 and Sir Francis Drake Boulevard in the City of Larkspur, as shown on the Site and Vicinity Map, Figure 1, which follows this page.

The properties which are adjacent to the boundaries of the site and their presently known development plans are as follows:

Wood Island

The 5.96-acre hilltop parcel, Wood Island*, Elevation +56.0 Mean Sea Level (MSL), which lies between Highway 101 and the project site, is currently owned by Mr. Phopho Cosmas.** This property may be developed as a motel site.

Sir Francis Drake Boulevard

The northern boundary of the site is the existing 80-foot-wide right-of-way for east Sir Francis Drake Boulevard. The City of Larkspur proposes to reconstruct this portion of east Sir Francis Drake Boulevard, widening the right-of-way to 114.5 feet to accommodate two traffic lanes in each direction, separated by a landscaped median strip. On each side of the new road would be a 6.5-foot-wide sidewalk, and on the southern margin, a 10-foot-wide bicycle path would be constructed.

Hutchinson Quarry Property

North of Sir Francis Drake Boulevard is a 105-acre tract on which T. I. Corporation presently has contracts of purchase; a development team has been assembled for ferry-terminal-oriented residential and commercial development of this site.

*Parcel #04, Block #172, in Marin County Assessor's Map Book 18, pg 17
**c/o Graham & Jones, 310 Sansome Street, San Francisco, Calif. 94104

Marin Municipal Water District Corporation Yard

A 5.26-acre site bordering the north side of east Sir Francis Drake Boulevard is presently occupied by the Marin Municipal Water District. The City of Larkspur proposes to develop this property for a fire station.

Sanitary District Property

On an 8.75-acre site north of the road and east of the terminal site is a sewage treatment plant operated by Sanitary District #1. The Sanitary District either will expand its current operations by increasing its property boundaries to the north and east or will decide to move to a new location, possibly Point San Quentin. The Sanitary District is required to discharge its effluent in deep Bay waters by 1975 and must abandon the current discharge point just east of the terminal site.

State Lands Marsh

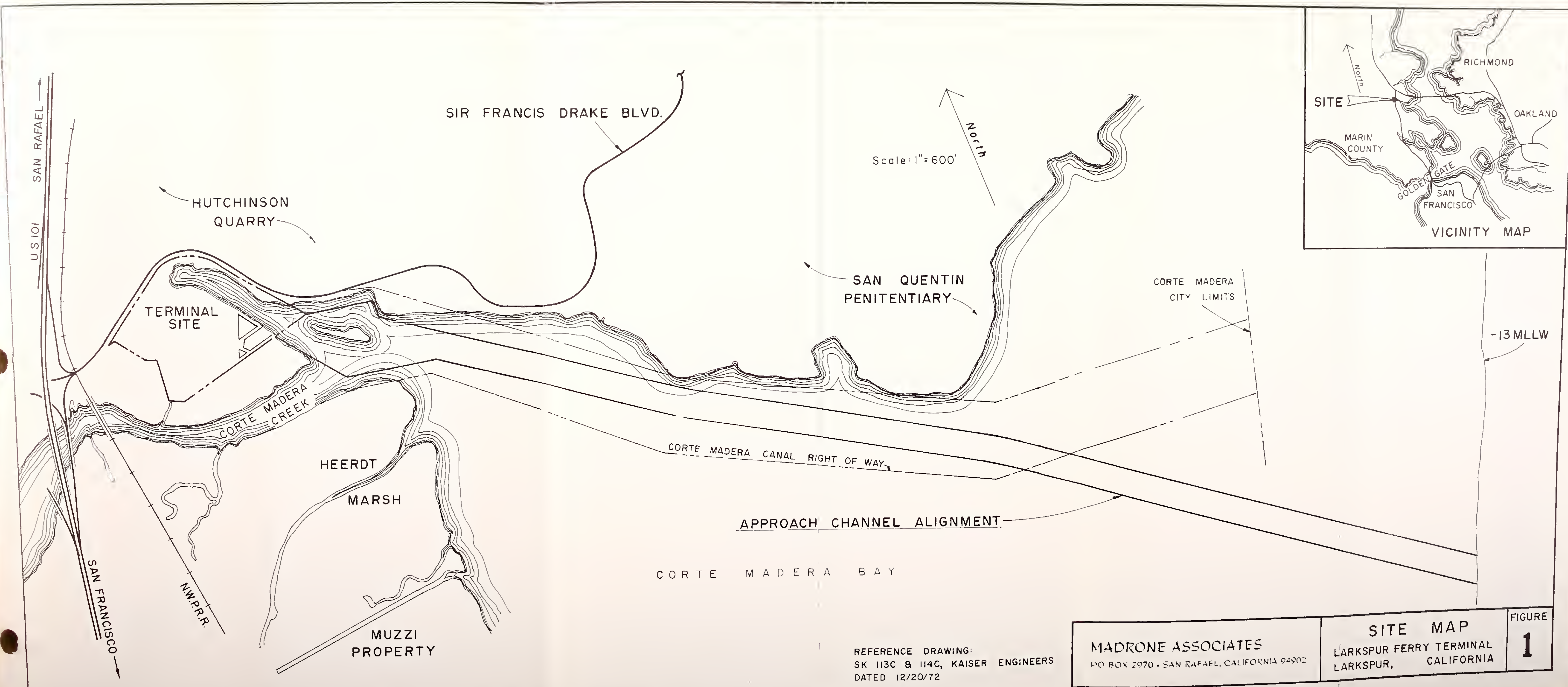
The southern boundary of the terminal site is a tidal marsh which is owned by the State of California. Terminal planning provides for preservation of the marsh and greater public access to views of the marsh and accompanying wildlife.

Corte Madera Creek

The southern edge of the marsh is bordered by Corte Madera Creek which extends eastward past Point San Quentin to San Francisco Bay. This waterway is owned by the State of California, but is under lease to the Marin County Flood Control District.

Abandoned Yacht Harbor

A 6.67-acre parcel of the State lands east of the terminal site has been leased from the State by the Von der Worth Corporation. This parcel extends north into the east Sir Francis Drake Boulevard right-of-way and into the Marin County Flood Control District to the south. The Von der Worth Corporation subleased the parcel to the Greenbrae Yacht Harbor, Inc., who began planning, construction and dredging for a small boat harbor. However, work was stopped on this harbor and the Marin County Flood Control District became leaseholder of the water rights for the portion of the leased area which extends into the Flood Control Channel Boundary. It is understood that the State Lands Commission has started proceedings to terminate the Von der Worth lease.



REFERENCE DRAWING:
SK 113C & 114C, KAISER ENGINEERS
DATED 12/20/72

MADRONE ASSOCIATES
P.O. BOX 2970 • SAN RAFAEL, CALIFORNIA 94902

SITE MAP
LARKSPUR FERRY TERMINAL
LARKSPUR, CALIFORNIA

FIGURE 1

2. Project Objectives

The Larkspur Ferry Terminal project is designed as part of a network planned by the Golden Gate Bridge, Highway and Transportation District to offer residents of Marin County alternative means to the automobile in commuting to San Francisco, namely ferry and/or bus service. Figure 2 is an artist's sketch of the project.

3. Project Description

Figure 3, an aerial photograph, shows the project areas, including the alternative sites and the nearby Heerdt and Muzzi properties.

The initial stage of the project (Figure 4) is construction of facilities for the operation and maintenance of three 750-passenger ferries. These include

- A space-frame terminal structure over a pile-supported reinforced concrete deck, which is underlain by an excavation sloping to a depth of 23 feet (present site elevation is +7 to +9, MSL Datum).
- Commercial facilities catering to ferry patrons.
- Two boarding floats and a service float with accompanying maintenance facilities.
- Service building.
- A 600-car asphalt-paved parking area.
- Four, 30-foot diameter, 10-foot high fuel storage tanks.
- Riprap along edge of channel from -5 to +6 feet MSL.

The Master Plan for the area (Figure 5) includes ultimately

- 50,000 to 125,000 square feet of specialty commercial space to attract non-commute and weekend ferry patronage.
- A second 600-car parking area.

- Additional facilities to improve public access to the Bay.

In addition, a 9700-foot approach channel is to be built north of the Larkspur-Corte Madera city line, which will follow the Corte Madera Flood Control channel to the Bay. Dredging of the approach channel will remove portions of the mud flat along Corte Madera Flood Channel bayward from the Heerdt Marsh and a 3/4-acre pickleweed island north of the confluence of the barge channel and Corte Madera Creek.

The project involves dredging approximately 1,300,000 cubic yards of bottom sediments, approximately 390,000 from the harbor area and approximately 910,000 from the approach channel.

The Golden Gate Bridge District plans coordination of bus service with the ferry at the Larkspur Terminal site. The District has under consideration additions to its present fleet, which would be assigned to the five proposed routes serving the terminal during peak commute hours. These routes, also tentative, would bring commuters to the ferry terminal from the following points: (1) Kent Woodlands via Larkspur and Corte Madera; (2) Fairfax via San Anselmo and Greenbrae; (3) San Anselmo via Miracle Mile and San Rafael; (4) Peacock Gap via East San Rafael and San Rafael; and (5) Terra Linda via Highway 101. Assuming that the ferries left the Larkspur Terminal every 30 minutes, the buses would arrive from and depart for their respective destinations at about the same intervals.

The District's plan offers flexibility of transportation arrangements. A commuter could travel to San Francisco by ferry

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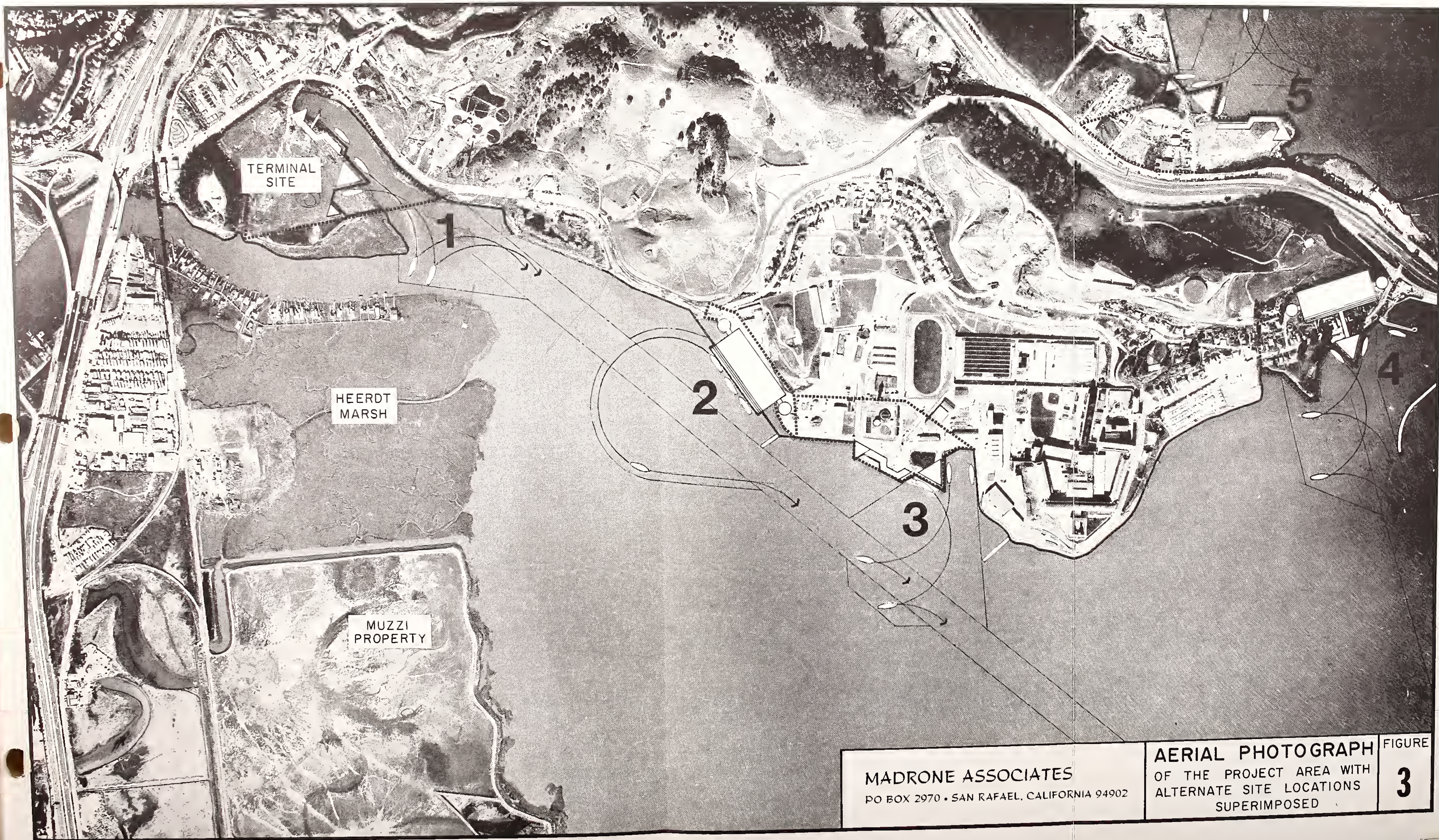
ARTIST'S SKETCH
OF THE PROPOSED LARKSPUR FERRY TERMINAL

FIGURE 2



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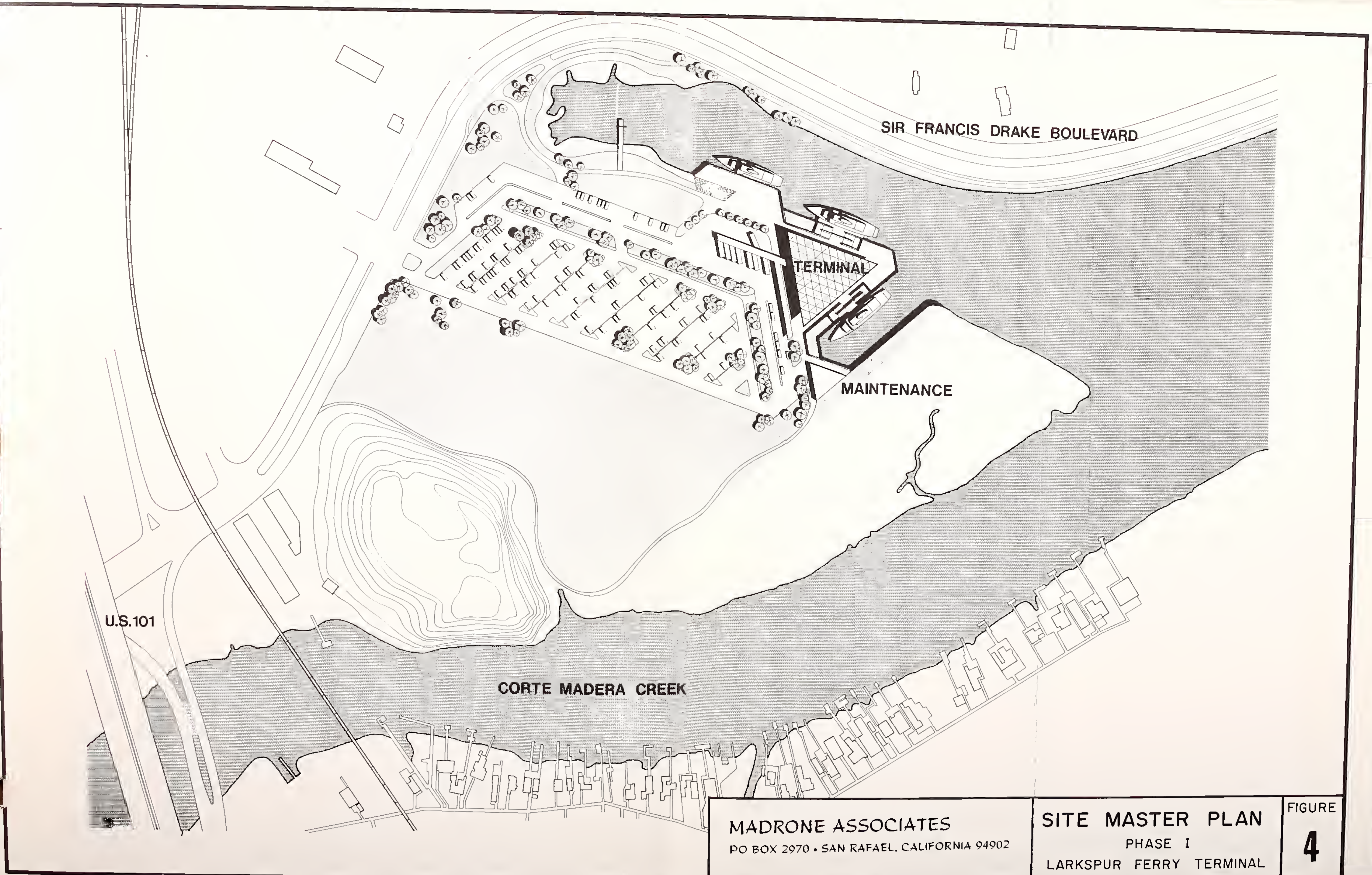
AERIAL PHOTOGRAPH
OF THE PROJECT AREA WITH ALTERNATE SITE LOCATIONS SUPERIMPOSED

FIGURE 3



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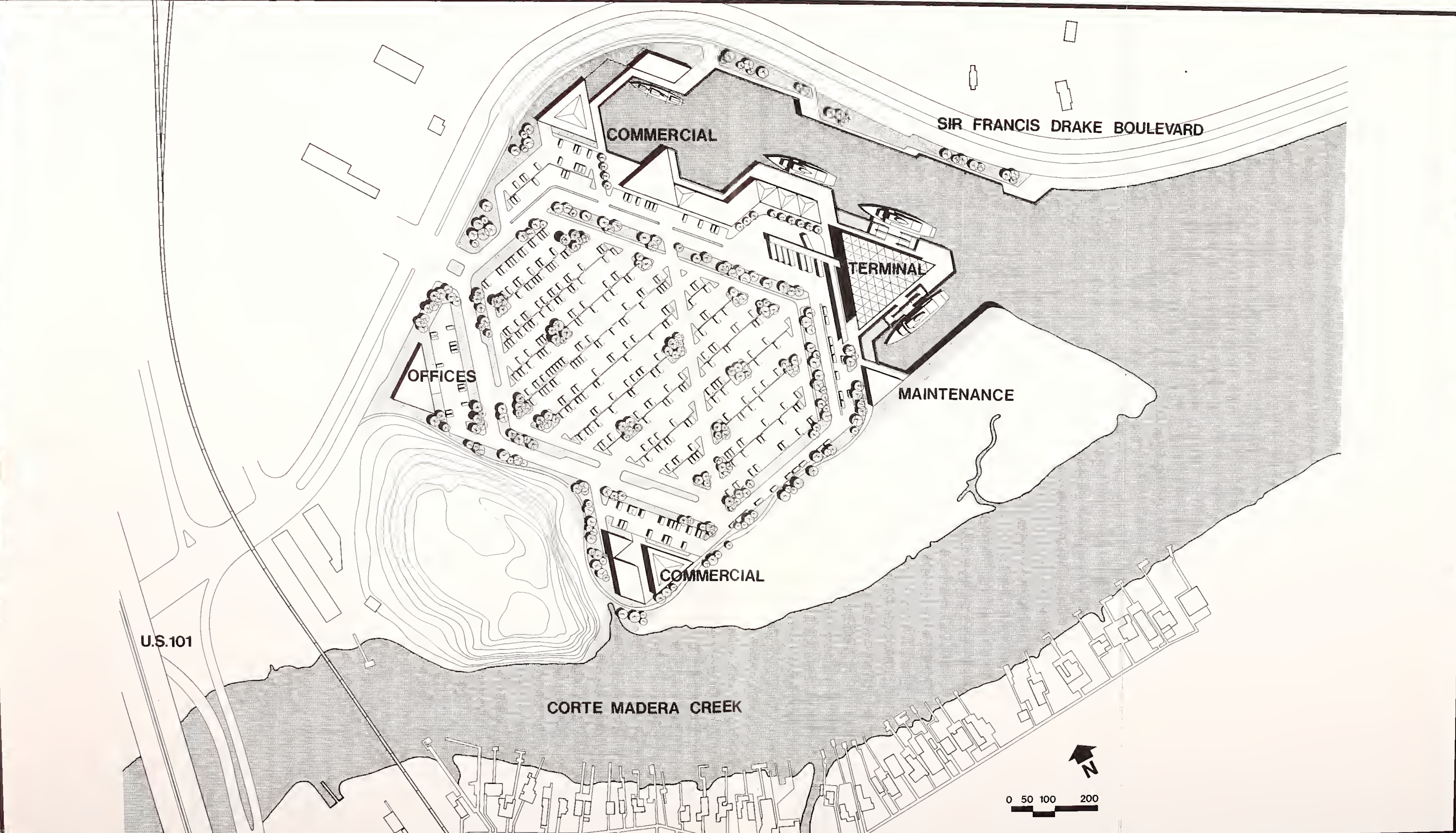
SITE MASTER PLAN
PHASE I
LARKSPUR FERRY TERMINAL

FIGURE 4



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SITE MASTER PLAN
LARKSPUR FERRY TERMINAL
LARKSPUR, CALIFORNIA

FIGURE 5

and return to the Larkspur site by bus to pick up his car or make further bus connections. Another feature of the planned transportation network is the use of the existing Northwestern Pacific Railroad right-of-way or guided rail system, which would pass immediately adjacent to the ferry terminal.

B. DESCRIPTION OF ENVIRONMENTAL SETTING (Section 15142)

1. Regional Setting

a. Traffic on Highway 101 to the Golden Gate Bridge

The Larkspur Ferry Terminal site is situated at the delta of Corte Madera Creek and the entrance of the Ross Valley, in the densely populated eastern urban corridor of Marin County. Ninety-five thousand automobiles now travel daily via Highway 101 across the Golden Gate Bridge from Marin County to San Francisco and back. Since the mid-60's traffic volume has exceeded the peak-hour capacity of three lanes on the bridge (1700 cars per lane). The present morning peak-hour volume is between 6,000 and 7,000 cars, often exceeding the capacity of four lanes. (For a complete report on traffic see Appendix I.)

In 1970, Marin County had a population of 207,000. This figure is forecast to rise to 333,000 by 1990.(1)* Without alternatives such as ferries, buses, an additional bridge, or rapid transit, traffic on the Golden Gate Bridge is forecast to increase from the present 95,000 automobiles to between 130,000 and 200,000 by 1990, depending on both Marin and Sonoma County growth policies.(2)

Estimates of commuter patronage in 1975 for a central Marin ferry service range from 3,200 to 8,500 riders per day; the former figure is based on empirical methods (see Appendix A), the latter on attitude surveys. Based on studies of Sausalito ferry users in 1970, 2,100 of the 3,200 will be former automobile

* Numbers in parentheses refer to Reference List.

commuters. With an average of 1.3 persons per auto, 1,600 autos will be removed from Highway 101 and downtown streets of San Francisco. The round-trip saving will be approximately thirty miles or 48,000 vehicle-miles of travel per day. After 1975, the addition of ferries would increase this figure.

In addition to increases in commuter traffic, local traffic volume on Highway 101 would be affected by the construction of either of two proposed regional shopping centers: one on property owned by W. W. Hahn, Inc., east of Highway 101 in Corte Madera, and the second on a site south of Sir Francis Drake Boulevard and west of Highway 101 in Larkspur.

b. Air Quality in the Ross Valley Basin

The Ross Valley Basin is surrounded by elevated terrain on all but the east side where it opens to tye Bay and to the influence of sea breezes. Typically, air is drawn up into the valley from the Bay with daytime heating and drains back with night-time cooling. Pollutants from early morning commute traffic on Highway 101 are thus carried into the valley and may travel back and forth many times before a sufficiently strong ocean breeze clears them out. According to the Bay Area Air Pollution Control District Source Inventory of Air Pollutant Emissions, motor vehicles are the primary polluters of air, and pollution level patterns closely follow traffic patterns with the highest levels found along major routes of travel such as Highway 101 and Sir Francis Drake Boulevard.[3]

c. Land Use in the Project Vicinity

(1) Residential

Residential development in the vicinity of the site consists of small cottage-style houses along a boardwalk which extends into the Heerdt Marsh and lies across Corte Madera Creek from the project site. Also, there are larger homes in Greenbrae, west of Highway 101 and north of Sir Francis Drake Boulevard, some of which are built on a hill overlooking Corte Madera Bay and the project site.

(2) Nonresidential

The portion of San Quentin peninsula within the city of Larkspur comprises approximately 200 acres, much of which has been historically devoted to industrial use. The Hutchinson quarry and asphalt plant north of Sir Francis Drake Boulevard has been in operation sicne 1924; however, the quarry is scheduled to be closed by 1977.

Besides the quarry, nonresidential facilities consist of the following: a Marin Municipal Water District Yard, a railroad-car restoration enterprise, a Go-Kart track, a County corporation yard, the Remillard Brick Works, and the sewage treatment plant of Sanitary District No. 1. The present location of the outfall from this plant is the confluence of the barge channel and Corte Madera Creek, but it is expected to be relocated to deep water 5000 feet east of Point San Quentin as part of the program of consolidation and facility improvement by Sanitary

District No. 1 and Improvement District A. At present, the timing of the expansion or relocation of the present treatment plant is uncertain.

The State of California Department of Corrections has jurisdiction over 200 acres of land reaching to the tip of Point San Quentin; approximately half of this area is occupied by the State facility, San Quentin Prison; the State has considered phasing out the prison and has called for a study to that effect by June 1974. With recent increases in the prison population, it now appears that San Quentin will remain in operation for the "foreseeable future."

Wood Island lies south of Sir Francis Drake Boulevard between the ferry site and Highway 101. An auto repair and towing service is located along Sir Francis Drake Boulevard. The Larkspur General Plan suggests Wood Island is "suitable for an office complex or possibly a motel" because of its highway proximity and topographic separation from surrounding lands.

A Northwestern Pacific Railroad trestle crosses Corte Madera Creek and Sir Francis Drake Boulevard. This trestle and the line to the south are used infrequently and will probably be discontinued eventually. The Golden Gate Bridge, Highway and Transportation District expects to acquire the right-of-way for future mass transit service.

d. Adjacent Natural Communities

(1) State Lands Marsh

Although the marsh owned by the State Lands Commission is not technically within the project area, it will be

vitally affected by the proposed activities, and therefore will be considered in the biological assessment of the project site.

(2) The Heerdt Marsh

Across Corte Madera Creek from the site is a salt marsh of over 93 acres, owned by W. J. Heerdt of San Francisco.* This is the last remaining undisturbed marsh larger than 10 acres in the Ross Valley. On its edge, bordering Corte Madera Creek, is a 200-foot-wide strip which contains the Greenbrae boardwalk and old dwellings known originally as the Hugh Porter Subdivision. The western border of the marsh is marked by Northwestern Pacific Railroad tracks; along this boundary, over five acres belonging to Harold D. and Sara B. Holtzinger have been filled. (See Appendix B for a map of the Heerdt Marsh and a plant species list.)

Two rare and endangered species are known to live in the Heerdt Marsh. The California clapper rail (*Rallus longirostis*) has been sighted on numerous occasions by Madrone staff and area residents. The salt marsh harvest mouse (*Reithrodontomys raviventris*) was trapped there in a study by the California Department of Fish and Game in 1971.

2. Description of Existing Project Area

a. History and Archaeology

The Larkspur Ferry Terminal site originally was part of the extensive Ross Valley marshlands. Since the entire site is on fill known to have been placed since 1924, there are no archaeological sites to be considered in this project.

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* Assessor's Parcels 23-04-12, 23-04-04, 23-04-09.

Neither the proposed channel to be dredged, nor the Muzzi property involve known historical or archaeological sites.

A detailed report may be found in Appendix C.

b. Geology and Soils

(1) The Terminal Site

The terminal site is filled marshland formerly within the tidal zone of San Francisco Bay. The existing surface slopes from Elevation +10 MSL on the east side to about Elevation +4 on the west side. Most of the surface lies between Elevation +6 and +8 MSL.

The terminal site area was developed as follows:[(4)] the channel northeast of the property was dredged in 1924 to provide barge access for the Hutchinson quarry; the dredging spoils were deposited within 300 to 400 feet of the shoreline opposite Sir Francis Drake Boulevard; next, dry fill was placed intermittently until 1960, with the major fill operations occurring in the late 1940's and late 1950's. The fill placed in the 1950's was compacted with sheepsfoot rollers. Engineering inspection was not provided during fill placement.

Information regarding subsurface conditions within the project limits was obtained by drilling 37 test borings in the locations shown on Figure 6; the chemical composition of materials to be dredged was determined by sampling sediments in the 13 locations also shown on Figure 6.*

* The boring logs and the results of laboratory tests are available for review at the offices of Harding-Lawson Associates, 55 Mitchell Boulevard, San Rafael, California.

Material types encountered in test borings at the terminal site are fill, bay mud, alluvial soils, and bedrock. These are described and their depths given in the table below. The relative thicknesses are depicted on Figure 7 which illustrates a subsurface profile in the vicinity of the terminal structure.

Typical Depth Below Ground Surface (feet)	Soil/Rock Type and Description
0 - 6	Fill: generally loose and soft, composed of clayey and sandy quarry waste, silty and clayey dredge spoil.
6 - 45	Bay Mud: predominantly a silty clay or clayey silt marsh deposit that is soft and compressible.
45 - 65	Alluvial Soils: predominantly sandy clays of moderate to high strength and low compressibility.
60	Bedrock of the Franciscan melange: predominantly sandstone and shale. The rocks are deeply weathered, closely fractured, weak to moderately strong, and of low hardness.

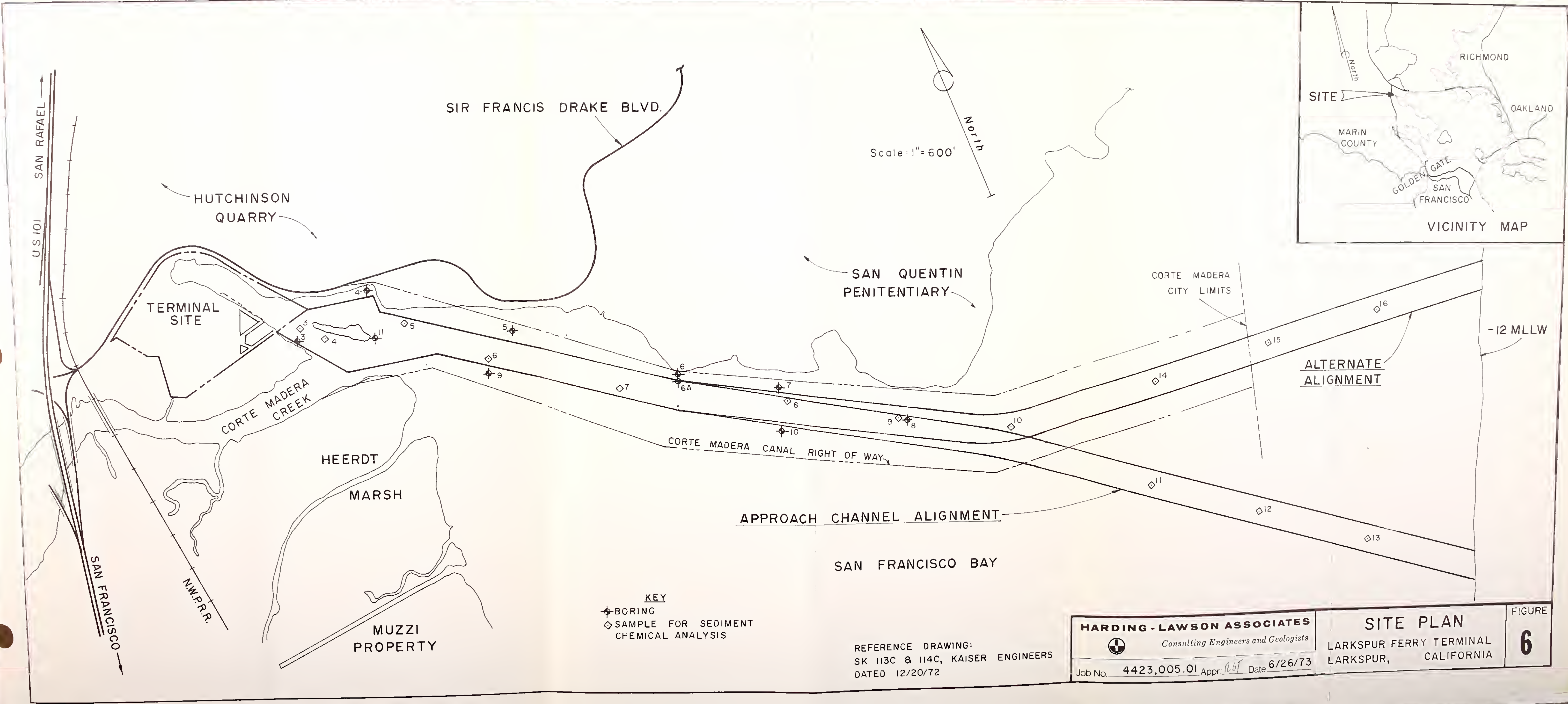
(2) Approach Channel

The planned approach channel location crosses a mud flat area and lies within the right-of-way limits of Corte Madera Creek.

The borings in the approach channel indicate that the channel section contains bay mud for virtually its entire length.

(3) Earthquake Faults

There are no known active faults within the project limits. The closest active faults are the San Andreas, nine miles to the west and the Hayward, nine miles to the east.[5]



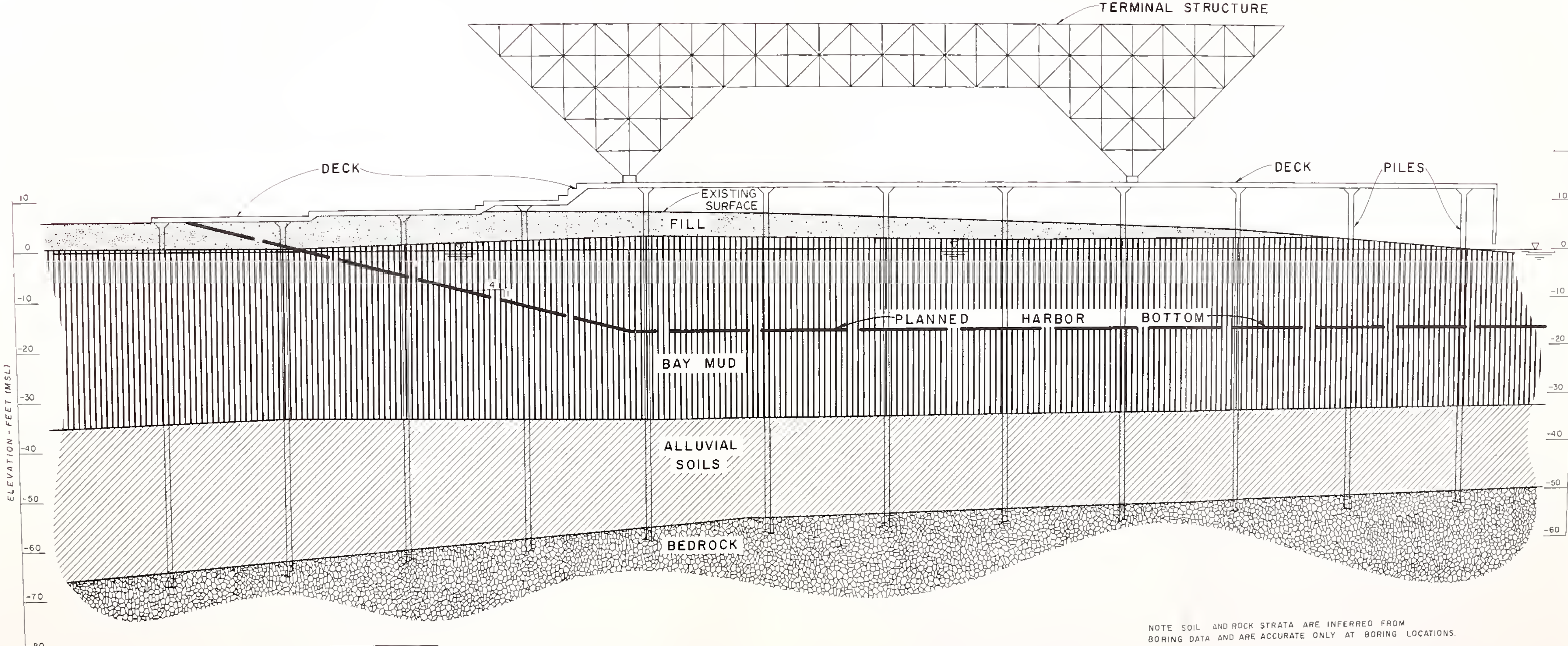
REFERENCE DRAWING:
SK 113C & 114C, KAISER ENGINEERS
DATED 12/20/72

HARDING - LAWSON ASSOCIATES
Consulting Engineers and Geologists

Job No. 4423,005.01 Appr: RGT Date 6/26/73

SITE PLAN
LARKSPUR FERRY TERMINAL
LARKSPUR, CALIFORNIA

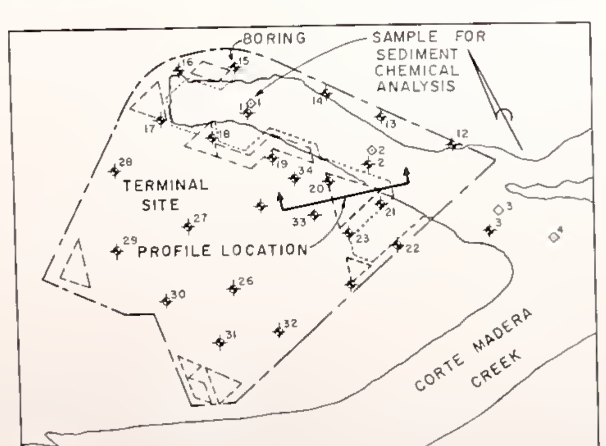
FIGURE 6



NOTE SOIL AND ROCK STRATA ARE INFERRED FROM BORING DATA AND ARE ACCURATE ONLY AT BORING LOCATIONS.

0 10 20 30 40 50 75

SCALE



KEY MAP
Not to Scale

Job No. 4423,005 .01 Designed RGT Drawn ATG/RRR Checked Approved Date 6/26/73 Scale As Shown	HARDING - LAWSON ASSOCIATES Consulting Engineers and Geologists	SUBSURFACE PROFILE AT TERMINAL STRUCTURE LARKSPUR FERRY TERMINAL LARKSPUR CALIFORNIA	FIGURE 7

c. Visual

Dramatic 360-degree views of San Quentin peninsula, of Corte Madera Creek and the Heerdt Marsh, of Wood Island with Mt. Tamalpais in the background and of Highway 101 with Greenbrae hills and the Hutchinson quarry are possible from the site because of the flat topography and low sparse vegetation.

Detracting from the beauty of the surrounding landscape is the present condition of the site itself. It has been used for stockpiling gravel and for disposing of excess asphalt and debris. Some debris has been carried onto the site by high winter and storm tides and much of it has been deposited on the State-owned pickleweed marsh. Most of the plants on the site grow along the edge and consist of assorted upland vegetation such as grasses, anise, thistles, as well as scattered clumps of pampas grass.

The site is visible from a number of houses in Greenbrae facing bayward from across Highway 101; from the Hutchinson quarry property; from the houses along Greenbrae boardwalk on the Heerdt marsh; from the east side of Wood Island and, of course, to boaters along Corte Madera Creek.

d. Biological Assessment

The salt marshes and mud flats of estuaries are among the most productive communities in the world. Their importance has been magnified by diking and filling operations, which have eliminated 75 percent of the salt marshes and mud flats that bordered San Francisco Bay one hundred years ago.[6,7] Since the

proposed Larkspur Ferry Terminal is located at this important land-water interface, studies have been conducted from October 1972, to June 1973, to evaluate the impact of the ferry terminal on the various plant and animal communities to be affected.

The vegetative communities of the marshes and mud flats which form the base of the complex food chains in San Francisco Bay have been analyzed, and studies have been made of the bird and invertebrate populations. See Appendix D for the complete study.

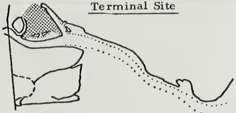
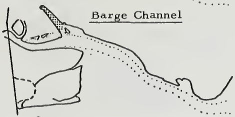
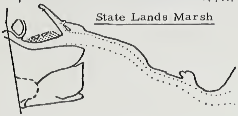
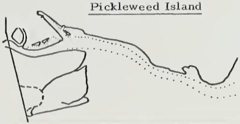
Following is a descriptive summary of each of the geographic areas within the project. (See Figure 8.)

(1) Terminal Site

About 20 acres of the proposed terminal site consist of imported fill with little topsoil or humus, sparse weedy vegetation and patches of asphalt. Annual grasses, pickleweed, plantain and redstem filaree are the most numerous plant species, though brass buttons, wild anise, yellow sweet clover, dandelion and gum plant are all commonly found. Scattered clumps of pampas grass are prominent over part of the site. Paralleling the barge canal is a bank of dredge spoils rather densely covered with a mixture of plants from the salt marsh and upland communities; pickleweed, salt bush gum plant, salt grass and brass buttons represent the former; mustard, wild radish, annual grasses, dock and thistles, the latter.

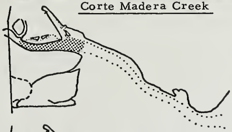
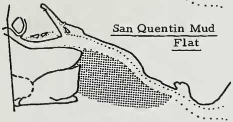
Sparrows, red shafted flickers, mourning doves, finches and meadowlarks are commonly sighted where the vegetation is dense, and killdeer frequent the open spaces. Throughout the study period, California jack rabbits, western fence lizards, garter snakes and meadow mice were sighted.

Figure 8. Summary Table of Existing Wildlife in Project Area (1)

Area	Sampling Areas	Acres	Wildlife Habitat Rating Value	Vegetation	Invertebrates	Other Wildlife
Terminal Site 	Bird Census Area G Invertebrate Sampling Station 6 Vegetation Section III, IV	25	low	Sparse vegetation-upland weedy species such as annual grasses, filaree, plantain, wild anise, dock, etc.	Insects associated with vegetation such as dock beetles, anise swallowtail butterflies	Black-tailed jack rabbits, meadow mice, mourning doves, killdeer, garter snakes
Barge Channel 	Bird Census Area B Invertebrate Sampling Stations SQ 6, 9, 10, 11 Algae Sampling Stations SQ 6, 10, 11, 16	8.5	moderate	Diatoms, green flagellates, sulfur bacteria	Oligochaete worms, polychaete worms	Avocets, sandpipers, willets, plovers, egrets, ducks (small flocks swimming)
State Lands Marsh 	Bird Census Area D Invertebrate Sampling Station SQ 17 Vegetation Section I Algae Sampling Station 1	5	high	Pickleweed, cord grass, salt grass	Amphipods, isopods, polychaete worms, Gemma gemma (small clams), Macoma balthica (large clams)	Meadow mice, California clapper rail nest, ducks (mallard eggs found), sandpipers, willets, egrets, avocets, plovers, meadowlarks (nest and eggs), sparrows, finches, blackbirds
Pickleweed Island 	Bird Census Areas A, C Invertebrate Sampling Stations SQ 3, 4 Vegetation Section II Algae Sampling Stations SQ 3, 4	1	high	Pickleweed--heavy stand, scattered clumps of cord grass	Polychaete worms, oligochaetes (near sewer outfall), amphipods, Gemma gemma clams, ostracods	Willets, least and western sandpipers (large flocks), marbled godwits, curlews, cormorants, plovers, egrets

(1) See Appendix D for a complete listing of species in each area.

Figure 8.(continued)

Area	Sampling Area	Acres	Wildlife Habitat Rating Value	Vegetation	Invertebrates	Other Wildlife
Corte Madera Creek 	Bird Census Area E Invertebrate Sampling Station SQ 12 Algae Sampling Station SQ 12	15	high	Ulva, green algae	Polychaete worms, amphipods, Gemma gemma (small clams) Mya arenaria (large clams), Macoma balthica (large clams)	Fish: steelhead, striped bass, perch, sculpin, perch, starry flounder; Birds: mallard, pintail, ruddy, canvasback, bufflehead, scaup ducks; coots, egrets, grebes
San Quentin Mud Flat 	Bird Census Area F Invertebrate Sampling Station SQ 5, 6, 7, 13, 14, 15 Algae Sampling Station SQ 6, 13, 14, 15	149	high	Diatoms--Navicula and Gyrosigma Green and blue-green algae	Polychaete worms, amphipods, Gemma gemma (small clams), Macoma balthica (large clams)	Fish from the above list no doubt wander across the mud flat at high tide to feed; Birds: willets (flocks), least and western sand-pipers (flocks of several thousand in migrating season), marbled godwits, curlews, herons

(2) The Barge Channel

The barge channel has not been dredged for a number of years; consequently, considerable sediment has settled in it and at very low tides only a very shallow, narrow channel flows into Corte Madera. A sewage outfall empties into Corte Madera Creek near the entrance to the barge channel. Dense populations of the green flagellate Euglena, oligochaete worms and sulfur bacteria are indicative of the high organic content of the channel sediments. Flocks of sandpipers and avocets feed along the channel and sewer outfall particularly in the fall and winter. Migratory ducks swim in and out at higher tides, particularly during the winter storms.

(3) State Lands Marsh

Approximately five acres of State Lands Marsh separates the terminal site from Corte Madera Creek. Pickleweed is the dominant plant in this healthy marsh. Stands of cord grass grow about the edges and along the meanders. The California clapper rail, an endangered species, has been sighted in this marsh. In May 1973, an empty clapper rail nest was found on a clump of cord grass by Madrone staff and the California Department of Fish and Game. While the habitat is suitable for another endangered species, the salt marsh harvest mouse, none were caught in trappings conducted twice in May and once in June. A variety of other wildlife uses the marsh, including resting shore birds and ducks, meadow mice, and an abundance of invertebrates such as amphipods and isopods. Flocks of blackbirds have been seen roosting at the tip of the

peninsula in the early morning hours. Part of the State Lands property is an upland area where large ponds of accumulated rainwater form in the winter. These are favored by avocets and killdeer, particularly in stormy weather.

(4) Pickleweed Island

An acre of dense pickleweed marsh with a few scattered clumps of cord grass has developed on a spoils island. The part of the island near the sewer outfall, rich in oligochaete worms, attracts avocets. The southern and eastern portion of the island is a favorite spot for large flocks of dunlins, western and least sandpipers, marbled godwits, coots, willets and plovers, all of which feed on a variety of invertebrates such as crustaceans, clams and worms.

(5) Corte Madera Creek

The mouth of Corte Madera Creek, throughout the project area is highly important to a variety of wildlife. Steelhead trout migrate up the creek from the Bay to spawn; juvenile and adult striped bass and perch feed and rest in the estuary; a variety of fish, including starry flounder, staghorn sculpins and goby fish, are year-round residents. A total of twenty-nine species have been found in Corte Madera Creek in various recent inventories (see Appendix D-4). The bottom of the creek is rich in invertebrate populations--small and large clams, amphipods and worms. Migratory ducks--bufflehead, canvasback, ruddy, pintail and scaup--rest and feed along the creek, particularly during heavy winter storms. In the spring a number of unusual birds were sighted by Madrone staff in the channel near the prison; these include: red-throated loons,

eared and pied-billed grebes and mergansers. Egrets feed along the edges of the creek and the clapper rail crosses from the State Lands Marsh to the Heerdt Marsh.

(6) San Quentin Mud Flat

A significant proportion of the total primary food production of an estuarine-marsh system is produced by mud flats. Dense populations of the diatom, Navicula, cover the Corte Madera mud flats, which in turn support large invertebrate populations: amphipods, small and large clams and polychaete worms. The annual late spring or early summer "bloom" of both algae and invertebrate populations is a highly significant event for all the wildlife. Fish remain primarily in the deeper channel but no doubt range over the mud flat to feed at higher tides. Thousands of migrating birds feed on the mud flat in the spring and fall, adding their numbers to the flocks of over-wintering birds. Willets, dunlins, western and least sandpipers gather on the mud flat near the Heerdt Marsh and, as the tide recedes, move out to the outer portions of the mud flat opposite the prison grounds. Here the substratum is coarser, with a corresponding increased density of invertebrate populations. The birds concentrate on the exposed outer mud flat edge near the prison grounds and spread out as they feed across the entire bay mud flat. Herons and egrets stand on the edge of drainage channels to fish and rest, while curlews, godwits, plovers, avocets, dowitchers and whimbrels move about in search of their particular choice of invertebrate.

Figure 8 summarizes existing wildlife in the project area.

e. Socio-Economic

(1) Community Services and Facilities

(a) Police Protection

Police services are to be provided by the Larkspur Police Department, located at 250 Doherty Drive, about one mile from the site. There are presently 13 officers (1.08 sworn officers per thousand population). The proximity of the station to the site and easy access to Highway 101 permit an estimated response time of 3-1/2 minutes.

(b) Fire Protection

Fire protection is to be provided by the Larkspur Fire Department. There are two fire stations in Larkspur at 400 Magnolia Avenue and 150 South Eliseo Drive. The latter station is within one mile of the ferry terminal site, and response time is estimated to be two to three minutes. The South Eliseo station has one engine and one reserve engine; a third engine, having a capacity of 1250 gallons a minute, is due to be delivered in 1973. The Larkspur Fire Department has 15 paid firemen and 50 volunteers, with two paid firemen on duty at South Eliseo 24 hours a day. Currently there is no water on the site, but two hydrants with a cumulative flow of 3500 gallons per minute have been planned at the suggestion of Fire Chief Craig Shurtz of Larkspur.

(c) Recreation

Present pedestrian and bicycle access to Corte Madera Creek along Sir Francis Drake Boulevard (east of Highway 101) is poor. In addition to the terminal site there are three or four places along the barge channel and Corte Madera Creek where automobiles

can pull off the road; however, all these areas become a mire with winter rains. The small beach close to the west gate of San Quentin and the tip of the ferry terminal site peninsula are favorite spots for fishermen. Recreational boating is very popular along Corte Madera Creek. Canoe clubs use the area for their activities, including lessons and wildlife excursions. Rowing teams practice along the lower reaches of the creek. Small motor craft moor all along Corte Madera Creek, many of them going out into San Francisco Bay. At the present time the larger boats are limited to higher tides as the present depth of the channel ranges from +1.5 to 15 feet MSL. Residents of the Greenbrae Boardwalk have a variety of small boats which are used locally.

(2) Public Utilities

(a) Sewer

The Larkspur ferry terminal site is served by County Sanitary District No. 1 which provides secondary level treatment with 85 percent removal of biological oxygen demand (BOD) and suspended solids. Total capacity is approximately 4.5 million gallons a day (MGD), while the average current flow is about 4.2 MGD. District No. 1 is currently under a cease and desist order issued by the Regional Water Quality Control Board. While there are no sewer lines on the site, a 36-inch pressure line, paralleling Sir Francis Drake Boulevard, leads to the sewage plant. The line runs along the north edge of east Sir Francis Drake Boulevard at a depth of five to six feet to a point somewhere along the curve of the road and thence cross-country to the sewage plant. (See Mitigation section, page 53 for recommendations.)

(b) Water

Larkspur is served by the Marin Municipal Water District, which has an existing storage capacity of 50,010 acre-feet in their five reservoir lakes in central Marin County. Data regarding past rainfall and watershed yields show the annual "net safe yield" of these reservoirs to be 28,000 acre-feet. Total water demand from MMWD in 1972 was 31,400 acre-feet. Because the yearly demand exceeds the "net safe yield," a moratorium on new connections was enacted by the MMWD Board on June 7, 1973 (Ordinance 121, Prohibitions and Restrictions on new water service connections). Section 13.01.110 of the variance procedures permits the Board of Directors to grant new connections if "restrictions would cause undue hardship to the applicant or to the public."[(8)]

(c) Solid Waste

Solid waste from Larkspur is collected by Marin Sanitary Service for disposal at the Redwood Sanitary Landfill north of Novato.

f. Water Quality and Storm Runoff

Storm runoff at the Larkspur Ferry Terminal site presently follows natural contours of the land before draining onto the State Lands marsh or into the receiving waters of Corte Madera Creek or the barge channel. The average annual runoff from the Larkspur site is estimated to be 16 acre-feet.[(9)] The character of storm water runoff is determined at its place of origin--in this case, a flat area of sparse vegetation, open soil and scattered patches of asphalt spoils. Typical sources of pollution of on-site storm water runoff are bird and mammal feces, other organic matter such as leaves and grass, and

soil and minerals leached from the soil. (See Appendix K for a full report on the impact on water runoff).

g. Offshore Sediment Analyses

In order to create a 9700-foot approach channel and a turning basin, 1,300,000 cubic yards of sediment will be dredged. From February 23, 1973, to March 7, 1973, borings were made and bottom sediment samplings collected at 13 locations in the turning basin harbor and channel. Sampling stations are shown on the map in Figure 6. Within the turning basin harbor, Stations 1 and 2 are in the berthing area; Stations 3, 4 and 5 in the turning basin; and Stations 6 through 13 are in the approach channel. (Analysis data sheets for each station are in Appendix E.)

Based on the current policy of the San Francisco Bay Regional Water Quality Control Board[10] (outlined in Appendix E), the sediments from Stations 1, 2, 3, 4 and 5 would be classified as polluted with heavy metals and therefore would have to be deposited on land or at the 100-fathom line in the Pacific Ocean (30 miles beyond the Golden Gate). Sediments from Stations 6 through 13 would be classified as polluted with organics and therefore would have to be deposited on land or at the disposal site in the vicinity of Alcatraz Island.

For further discussion of disposal of dredging spoils, see Impact and Mitigation sections, pages 36-40 and 51.

h. Noise Levels

The noise levels at the Larkspur Ferry Terminal site are dominated by truck traffic along Sir Francis Drake Boulevard hauling rock from the nearby quarry, by automobile traffic on Sir Francis Drake

Boulevard, and by traffic on U. S. 101. Most of these sources create a background or ambient noise level which is relatively constant from moment to moment but varies slowly from hour to hour as wind, human activity and traffic change. Superimposed on this slowly-varying background is a succession of identifiable noisy events of brief duration such as airplane flyover. Measurements were made from two locations near the terminal location, one across Corte Madera Creek along the Greenbrae Boardwalk at a maximum distance from Highway 101 and near ferry operational site and the second from a site north of east Sir Francis Drake Boulevard. The current levels exceed the National Cooperative Highway Research Program (NCHRP) criterion at 56 dBA (a weighted sound level). (A complete study will be found in Appendix F.)

The major sources of noise from the ferry terminal project will include

1. traffic on Sir Francis Drake Boulevard, east of Highway 101
2. parking lot activities
3. the ferry boats

i. Climate and Air Quality

The dominant factor that determines the climate of the entire San Francisco Bay area is its proximity to the Pacific Ocean. The large-scale flow of ocean air tempers the climate in direct proportion to proximity to ocean waters; thus the annual temperature range at the Larkspur site is approximately 46° F - 66° F as opposed to 51° F - 55° F at San Francisco. During the summer half of the year

(May through October), when there are few storms and the air flow along the Pacific coastline is almost invariably from the northwest, much of the marine air reaches the site via the Golden Gate, rather than directly from the coast. Winter wind cycles are not so regular, with winter storm winds typically blowing from south-southwest to south-southeast.

The hills surrounding the Ross Valley Basin to the west of the Larkspur site play an important role in air flow and thus in the climate of the area. Primary wind directions are usually aligned with the principal axis of the valley terrain as air is drawn up-valley with daytime heating, and drains back down with nighttime cooling.

The pollution potential of the Ross Valley Basin is high because of the high incidence of light winds (less than three knots) and the daily directional reversal of air flow in the Ross Valley Basin. This air passes back and forth across the valley several times and pollutants are increased. Oxidants are formed by the action of sunlight, which is most intense during the summer; oxidants are thus highest from June to October with peaks reached near mid-day. Carbon monoxide, oxides of nitrogen and hydrocarbons are highest from September to March with peaks occurring around 8:00 a.m. and between 6 and 10 p.m. These peaks coincide with the peak traffic and minimum capability of the atmosphere to disperse contaminants. (See Appendix G for a full study of air quality impact and Appendix H for a study of the potential impact on microclimate.)

Potential effects of development on climate and air quality are of two kinds:

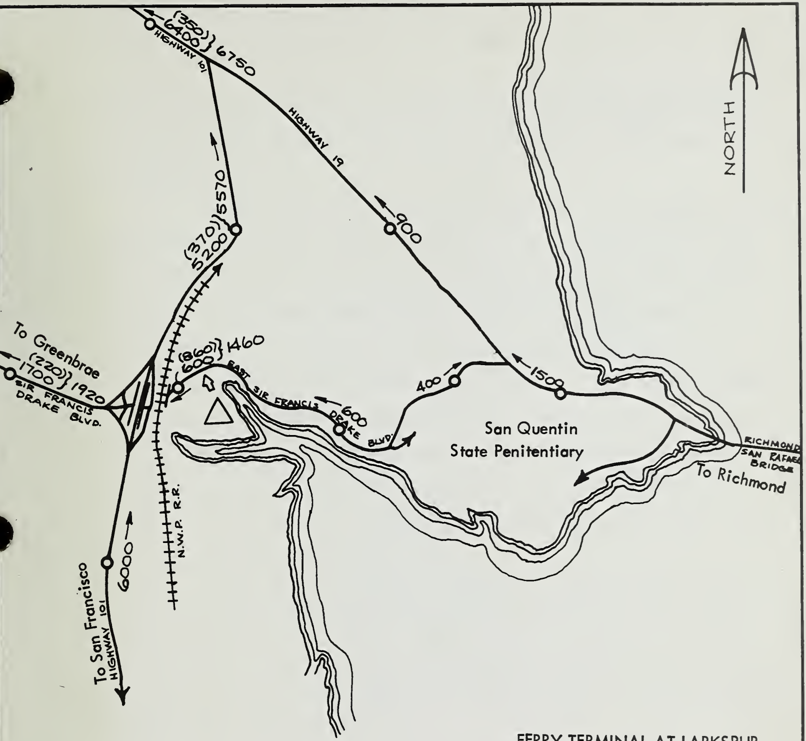
1. changes in the earth's surface properties that influence the energy exchange between the surface and the atmosphere, and thus produce changes in such parameters as air temperature and air movement;

2. man-made emissions of heat and pollutants that can modify the climate or may be harmful and/or unpleasant in themselves.

With the exception of a bank of dredge spoils covered with salt marsh and upland vegetation, the majority of the study area is low (5-10 feet elevation) with flat, hard-packed soil and intermittent patches of asphalt spoils and upland vegetation, a water surface (the barge channel and Corte Madera Creek bounds two sides of the site), and the State Lands marsh. Paving a parking area, constructing terminal facilities and increasing water surfaces by dredging represent changes in surface properties which will take place when the project is undertaken. In addition, the development will cause local and regional changes in traffic patterns.

j. Traffic

The portions of the Marin County roadway network that will be most affected by the project are east Sir Francis Drake Boulevard and Highway 101; Figure 9 shows 1975 p.m. peak hour and peak direction auto flow predictions on the above roadways. Highway 101 is built to freeway standards from the Golden Gate Bridge to Novato, with three freeway lanes in each direction north of Corte Madera most of the way to Novato. Traffic is heavy for



FERRY TERMINAL AT LARKSPUR

(000) Trips Added From Ferry

△ Ferry Terminal at Larkspur

Source: Marin County Balanced Transportation Program

MADRONE ASSOCIATES PO BOX 2970 • SAN RAFAEL, CALIFORNIA 94902	PEAK DIRECTION AUTO FLOWS 1975 P.M. Peak Hour	FIGURE 9

several hours of the day with severe congestion during the morning and evening commuter peak hour, when approximately 6,000 vehicles pass through the area.

East Sir Francis Drake Boulevard is a two-lane road with a peak traffic load for 1975 estimated at 600. Generally in Marin County, truck traffic makes up about five percent of total traffic but because of the Hutchinson Asphalt and Rock Quarry operation, truck travel on this stretch of Sir Francis Drake Boulevard is heavy and fluctuates with construction levels. Under normal operation schedules, all trucks are filled and leave the yard between 7:30 and 8:30 a.m., with return trips spaced throughout the day. The asphalt operation produces a maximum of 30-35 truckloads a day; the fill operation, a maximum of 60 truck trips per hour. The quarry is scheduled to close by 1977.

The City of Larkspur eventually plans to widen east Sir Francis Drake Boulevard to allow for divided two-way traffic with two lanes in each direction, pedestrian walkways and a 10-foot bicycle path. (For a full report on traffic impact at the Larkspur Ferry Terminal, see Appendix I.)

C. ENVIRONMENTAL IMPACT (Section 15143)

1. Environmental Impact of the Proposed Action

Impacts to the environment are summarized below. In areas where there is no way of quantifying the impact, estimates have been made by qualified consultants. More complete information is given in the technical Appendixes.

a. Historical and Archaeological

There are no long-term or short-term archaeological impacts expected.

Since the land portion of the project consists entirely of former marshland, filled since 1924, no archaeological impact is expected. See Appendix C for further information.

b. Geology and Soils

There are no impacts on geological or soil features. The geologic considerations of seismicity, settlement and creep have been taken into account in the design of the terminal.

(1) Seismicity

Seismic events will have an impact on the ferry terminal itself. During an earthquake, the response of the Larkspur Ferry Terminal site will be typical of many Bay margin properties in that the site will quite literally react to the impact of energy released through the mechansim of earthquakes. Here, as in the entire San Francisco Bay Area and Northern California, seismic events are unavoidable.

The nearest known active faults are the San Andreas and the Hayward, nine miles west and nine miles east of

the site, respectively. Several manifestations of earthquakes are possible at this site, and are summarized below; the severity of each will depend upon the intensity of the earthquake and its proximity to the property.

- The risk of ground rupture due to faulting is not significant.

- Lurch cracks, slumping and lateral spreading may occur on slopes or banks, depending on the tide level at the time of the earthquake and slope height and inclination.

- Landslides and submarine slides are possible, depending upon the stage of the tide at the time of the earthquake and the slope height and inclination.

- Soil liquefaction is an insignificant risk because subsurface soils and fills are of types which are not susceptible to liquefaction (grain size and density are determining factors).

- Risk of inundation by tsunamis is not significant. According to recent studies by the United States Geological Survey in 1972, only the State marshlands adjacent to the site may be affected by inundation from future tsunamis.(11) The USGS studies are based on a 20-foot-high wave impinging at the Golden Gate Bridge. The tsunami generated by the 1964 Alaskan earthquake affected some portions of San Francisco Bay but not the site in question.

(2) <u>Settlement and Creep</u>

Site settlement has occurred, and will continue to occur, as the natural soft bay muds consolidate under the weight of man-made fill. Thirty-year settlements will range from a few inches where no new fill is to be added up to three or four feet depending on the actual thickness of new fill.

The area at the tops of slopes adjacent to the waterway will move outboard very slowly over a long period of time. This phenomenon (creep) is a function of slope height and

inclination, bay mud thickness, and weight of overlying fill. It may range from a half a foot to more than two feet over a 30-year period.

(3) Shoaling

Continuous shoaling in the approach channel and turning basin will require maintenance dredging. The amount of shoaling will be reduced by the natural stream flow of Corte Madera Creek.

Shoaling will occur in the approach channel and turning basin that have been created by dredging of bed material. This is a significant problem in the San Francisco Bay system where harbors and channels have been made useless by shoaling rates that could not be economically compensated by dredging. (See Appendix J for a report on shoaling.)

Shoaling is reduced where the natural stream flows pick up and carry sediments along as they empty into the Bay. Since present restrictions on disposal of dredge spoils multiply costs greatly, "designing with nature" assumes increased importance. Waves generated by spring and summer onshore breezes and winter storms keep clay and silt materials suspended, while slow tidal currents circulate them throughout the system. (Most of this material is carried into the Bay system by winter and early spring rainfall and runoff.) The natural bed configuration is such that the rate of resuspension by wind-generated waves or by currents equals the rate of deposition. Modifications of the bed that will reduce the rate of resuspension, such as channelization, will result in shoaling unless the supply of suspended materials is also reduced.

Shoaling rates of 1.3 feet per year for the terminal basin and 1.2 feet per year for the approach channel were calculated assuming a six-foot range of tide, an average channel depth of 15 feet, and a strength of flood and ebb current of 0.15 feet/second. Further studies by consultants for the design team on the effects of wind forces and current patterns on sedimentation are presently underway. Spoils analyses required at the time of maintenance dredging determine available alternatives for spoil disposal. Future alterations of the sewage treatment plants and changes in the Regional Water Quality Control Board criteria for spoils disposal will be factors in the choice of a spoils disposal site.

(4) Erosion by Wave Action

Waves generated by ferries operating at low speed will have little impact on the Heerdt Marsh.

While marshes are subjected to considerable natural wave action and are stabilized against erosion by plants with extensive root systems, such as cord grass, the effect of waves generated by the ferries could have a significant impact on the tip of the Heerdt Marsh. This marsh, which faces the project site from across Corte Madera Creek, is the largest undiked marsh on Corte Madera Bay and is an irreplaceable asset.

Several studies have been made at the University of California to determine the characteristics of waves generated by moving ships, both in waters of uniform depth and in shoaling waters.[12] Typical ship-wave patterns consist of diverging waves

and transverse waves which form a constant pattern and meet to form a locus of cusps with an angle to the sailing line. In deep water this angle is about $19^{\circ}28'$, but it becomes greater as the water becomes more shallow. The magnitude of the maximum wave for a given ship is a function of the ship speed, the water depth and the distance from the sailing line. At highest speeds the waves are equally high or higher on the sloping beaches than in water of uniform depth. At lower speeds, waves appear to be lower on the slopes of the shoaling area than in water of uniform depth--apparently as a result of refraction effects. In all cases, even though waves may be lower on the beaches than in deeper water, they will peak up and break on the shoreline. The shoreline thus assumes great importance in breaking the force of waves along the margins of marshes.

The channel and turning basin have been designed to retain a 12-foot strip (approximately) of mud flat to protect the Heerdt Marsh. This strip will be sufficient to cause all but a few waves to crest and break before reaching the marsh edge with the ferries operating at low speeds. At certain levels of high to higher tides, waves will reach the marsh before cresting; however, the coincidence of ferry-generated waves and this particular tidal height will not be frequent. Waves generated by winds from the north are infrequent. The portion of the State Lands marsh most susceptible to wave action has a bank of spoils along the outer edge; thus the productive portions will not be affected.

c. Visual

There will be a major long-term visual impact.

In that the land use is to be changed from a nearly natural state to one of human activity, i.e. a ferry terminal and related commercial development, there will be a long-term visual impact. The terminal structure and a 600-car parking lot, followed by the construction of commercial buildings, will present a developed aspect rather than an open space perspective.

The major visual impact will be upon the owners of houses along the Greenbrae boardwalk, small boats entering and leaving Corte Madera Creek, the few houses on the hill in Greenbrae that overlook the Bay, traffic along Sir Francis Drake Boulevard east of Highway 101, and any future development on the Hutchinson Quarry property.

The terminal buildings are designed to be 35 feet in height; the parking lot, at ground level. Lights of cars and buses in the parking lot, as well as outdoor lighting of the facility, will be in view of the Greenbrae boardwalk.

d. Natural Habitat

A major adverse long-term impact will be the removal of 32.8 acres of bottom sediments, intertidal mud flat and salt marsh with their associated plants and animals. A short-term impact will be the removal of 50 acres of bottom sediments with benthic organisms that will be reestablished.

Increased flushing caused by deepened channels may have a beneficial impact on fish.

The primary impact of the project on fish and wildlife will be the removal of 32.8 acres of bottom sediments, intertidal mud flats and salt marsh with their associated invertebrates, algae and salt marsh plants, by the dredging operations necessary to provide an approach channel and turnaround basin for the ferries. A list of impacts on wildlife follows:

- The loss of any part of the mud flat and the pickleweed island will have repercussions extending into food chains which include invertebrates, fish and birds. Avocets, marbled godwits, and least sandpipers may be excluded from the area as a result of such losses.

- It has been estimated that the algal photosynthetic unit contributes one-fourth to one-third of the total primary production of an estuarine marsh ecosystem.(13) The major energy flow between plants and animals is by way of the "detritus food chain" with pickleweed and cord grass as the prime detritus source.(14)

- The loss of algae and marsh plants will remove a source of net oxygen production.

- Repopulation of the dredged channel by benthic (deep-water) organisms would begin soon after dredging. In a study conducted in Chesapeake Bay, the total number of individuals in bottom samples was restored in 18 months; however, species distribution and numbers were altered.(15)

- The loss of the pickleweed island and development of the terminal site will remove resting and feeding areas for shore birds.

- Development on the terminal site will remove habitat for land animals such as rabbits, mice, snakes, sparrows and meadowlarks.

- The increased flushing action caused by deepening the channels may have a beneficial effect for fish migrating upstream.(16)

- Piers and pilings would provide habitat for fish such as perch, a favorite recreational fish.

- The impact of the activity and noise generated by the terminal upon the endangered California clapper rail is unknown. The impact is assumed to be adverse, since this animal is secretive and is "apparently incapable of adapting to environmental change."(17)
- Hydraulic pipeline dredging and land disposal of spoils causes little turbidity; thus, no adverse impact would be expected on fish from the dredging itself. (See this section, pages 36-37 and 39-40; and Mitigation Section, page 51.)

e. Socio-economic Impacts

(1) Employment

There will be some new employment available to Marin residents.

With three ferries in operation, it is estimated that the Larkspur terminal will provide employment for 90 persons on and offshore. Jobs will range from a terminal supervisor, manager of ferry operations, to dispatchers, mechanics, deckhands, ticket agents, janitors and security guards. In addition, there would be jobs such as shopkeepers and waitresses in nearby commercial services.

(2) Property Values

The ferry will cause some increase in Ross Valley property values.

The presence of ferry service in Larkspur would probably increase property values throughout the Ross Valley area. In all likelihood, residents of the proposed development to the north would commute to San Francisco by ferry, while tourists and San Franciscans would patronize the ferry during off-peak hours.

BART studies have demonstrated that property values have increased where land is adjacent to public transit.[18]

Property assessment has increased in Larkspur; the 1973-74 tax base has been adjusted upwards.[19] The assessed value of the project site has almost doubled in two years.

(3) Revenues from Project Property

There will be a revenue loss to Larkspur from property taxes.

The last recorded taxes collected on the site were $14,963.16 for 1970-71[20] when it was owned by the Hutchinson Company. Golden Gate Bridge District, as a public agency, pays no taxes. The loss to Larkspur in revenue at the time of the sale of the property, February 14, 1972, was $1,705.80, and might be double that by 1974.

Sales taxes will accrue from an estimated $540,000 annual sales for commercial services in the terminal facilities at 1975 levels of patronage.[21] Additional revenues will be available when shops and restaurants shown in the Master Plan are developed.

(4) Services - Police and Fire Protection

There will be minimal impact on Larkspur services.

No increase in the Larkspur police force or number of firemen is anticipated.

Water usage is expected to be approximately 90,000 gallons per day. This will have an impact on the Marin Municipal Water District's already limited water supply.

(5) Recreation

Recreational facilities will be generally improved. There will be some adverse impact on small boats.

Bike paths and pedestrian walkways designated in the Larkspur Ferry Terminal Master Plan will provide pleasant views of the Bay and adjacent marshes and will be coordinated with those proposed in the City of Larkspur General Plan.

Small boat access to and from the Bay will be increased by the deepened channel. Small craft will generally occupy a separate parallel approach to the ferry channel; therefore, there should be minimum interference between the two types of vessels. Channel markers will separate the lanes to the turning basin area. However, the general rules of the road for navigation could present operational difficulties for the ferries if they have to give way to small craft.

(6) Public Utilities

(a) Sewer

Additional sewer facilities will be required.

Initial sewage flow from the ferry terminal is estimated to be 65 gallons per minute. A wet-well collection point for ferry boat and terminal operations, a grease and oil separator for ferry boat bilge water and a lift station to pump sewage to the plant of Sanitary District No. 1 will be required.

(b) Solid Waste Disposal

Solid waste will be generated by operation of ferries and the ferry terminal.

Facilities planned for the Larkspur Terminal that would generate solid waste include a cocktail bar, a coffee-and-donut bar, dispensing machines and restrooms. The same types of facilities are on the ferries themselves. Waste generated on the ferries would be deposited either at the Larkspur Terminal or at the San Francisco Terminal, depending on costs, which have not yet been determined. If deposited at Larkspur, solid wastes generated at the Larkspur Terminal, as well as those from the ferries, would be compacted and hauled away in 200-cubic-foot debris boxes. The Sausalito Ferry Terminal and the ferry at present generate one debris box every two days, or approximately 100 cubic feet of waste per day. Predictions for the Larkspur Terminal indicate that disposal rates would be between 100 and 200 cubic feet of solid waste per day.[22]

f. Water Quality and Storm Runoff

(1) Dredging

By deepening the channel dredging will have a long-term beneficial effect on the water quality of Corte Madera Creek.

Hydraulic dredging will have minimal short-term impact on turbidity and heavy metals release.

Dredging of an approach channel and turning basin will have a long-term beneficial effect on the water quality of Corte Madera Creek, particularly in the vicinity of the sewer outfalls. These outfalls carry large amounts of suspended solids, particularly during the rainy season. Where fresh water effluent meets salt water in Corte Madera Creek, flocculation and sedimentation

occur. While the Hutchinson Quarry barge was operating, Corte Madera Creek channel did not require maintenance dredging; however, after the outfall was constructed, siltation in the barge channel increased considerably.[4] Deepening of the channel near the sewer outfalls will result in far better flushing action. Maintenance dredging is anticipated at three-year intervals while the sewer outfalls remain in their present locations.

The deepened harbor and turnaround basin will widen the stream bed, resulting in increased deposition of sediments at the point where the water flow slows. Maintenance dredging at three-year intervals is expected to provide adequate depths for the ferries. There will be minimal short-term adverse impact on water quality in the immediate vicinity of the dredge due to increased turbidity and the possible release of heavy metals or organics. (See "Deep Water Spoils Disposal," below and Appendix E.)

Of the three methods of dredging, hopper, clamshell, and hydraulic, hydraulic dredging causes the least degradation of water quality. The hydraulic dredge has a revolving cutter which loosens the bottom silt. The sediments are pumped into a pipe that transports the spoils to a land disposal area. There is little or no apparent effect on water quality at the dredging end because most of the material loosened by the cutter head is sucked right into the dredge and pumped ashore directly[23] for settling and clarification of water present in the spoil.

(2) Deep-water Spoils Disposal

The impact of disposing spoils meeting Regional Water Quality Control Board standards at a deep-water site (near Alcatraz) in San Francisco Bay is considered to be minor.

The impact of disposal at the 100-fathom line is unknown.

(a) Dispersion of spoils

The effects of spoils disposal in marine and estuarine waters is poorly understood and has been the subject of considerable research recently. Dredged material released at the Alcatraz site is dispersed rapidly by the action of swift tides, and no build-up of material has been recorded on the bottom of the disposal area, which ranges from 122 to 164 feet in depth, with a mostly sandy bottom. Studies utilizing the Corps of Engineers Bay Model show that approximately 48 percent of the material released at the Alcatraz site is swept from the Bay system, while the remainder of the material circulates within the Bay. Of the remainder, approximately 28 percent will finally drift to the Bay bottom between the Oakland Bay Bridge and a point east of the San Francisco International Airport, while approximately 21 percent of the material will be deposited on the bottom between the Oakland Bay Bridge and San Pablo Strait. The remaining 39 percent of the material will be dispersed to the southerly and northerly portions of the Bay.

(b) Release of Toxic Materials

The release of toxic or complex organic materials, and the reduction of dissolved oxygen is directly related

to the length of time sediment surfaces are exposed to the oxidizing effect of the water. Settling of turbidity occurs faster in salt water than in fresh; in fact, settling in highly turbid samples was complete in three to four hours in salt water in a study conducted by the Environmental Protection Agency.[23] In a statement to the California State Water Resources Board on November 28, 1972, Robert Cooper, Professor of Environmental Health Sciences, University of California, Berkeley, outlined considerably conflicting data regarding the transfer of mercury from sediments to the biota living in the surrounding water.[24] Mercury found in fish is in the organic form of methyl mercury; on the other hand, in Bay sediments it is in a nontoxic inorganic state. Bacteria have been blamed for the methylation of mercuric compounds; however, none have been isolated from bay mud in spite of an intensive search.[25] Cooper states that in preliminary lab experiments on the "methylating capacity" of Bay sediments, it appears that any methyl mercury produced stays associated with the sediment rather than the overlying liquids and that even with Bay disposal there does not appear to be an acute environmental problem which needs immediate resolution.[24] Nonetheless, ingestion of food chain organisms contaminated with heavy metals causes accumulation of the metals. Chronic exposure to low levels may be lethal.

(c) Turbidity

While the impact of deep water spoils disposal is considered to be short-term, the potential effects of increased turbidity should be noted. Turbidity affects the photosynthetic

process of marine algae in that the suspended particles of sediment absorb and reflect light. The depth to which light penetrates water is inversely proportional to sediment concentration; hence, the temporary turbidity accompanying spoiling will interfere with photosynthesis which provides net oxygen to the water.[26] In such a situation, it is possible for an imbalance of plant respiration over photosynthesis to occur, resulting in a net oxygen loss.

Fish avoid turbid waters. Many fish, such as salmon and steelhead trout, are basically sight feeders and increased turbidity impairs their quest for food. Fish are not equipped with "gill cleaners," so they rely on a free flow of water through their gill chambers, the production of mucous, and an intermittent violent release of water similar to coughing. In laboratory experiments, long periods of high turbidity have caused gill damage (thickening of the cells of the respiratory epithelium and fusion of adjacent lamellae).[27] No such gross lethal effects or historical changes have been found in fish in the vicinity of actual overboard spoiling operations, although turbidity momentarily can reach 2,000 JTU's.[15,28]

(d) Oxygen Sag

Spoiling in open water may cause a momentary decrease in oxygen due to absorption by silt particles or oxygen demanding compounds in the spoils.

(e) Eutrophication

Spoiling may add to the disposal area nutrients which have biostimulatory activity; however, the flow of water in the Bay near Alcatraz is rapid and the dilution factor is enormous.

(3) <u>On-site Storm Runoff</u>

<u>Development on the terminal site will increase the on-site water runoff</u>.

The provision and use of the proposed parking facility is expected to have the following impacts on water quality:

- The peak flow rate and amount of storm water that enters offshore waters by surface runoff from the site will be increased because of curtailed contact with soil at the site.

- Materials will be imparted to storm waters which are not now imparted at the site, including the following:

  . Petroleum derivatives from fuel, lubricants and hydraulic fluids leaked from vehicles.

  . Compounds of lead, nickel and zinc, arising principally from leakages of fuel, lubricants and hydraulic fluids. A small amount of zinc will derive from material worn from tires.

  . Fine particles worn from tires and clutch and brake linings.

  . Dirt, rust, and decomposing coatings from fender linings and undercarriages.

  . Vehicle components broken by vibration or impact (glass, plastic, metals, etc.)

  . Asphalt and various products of decomposition of asphalt.

  . Constituents of paints used on the surface of pavement.

  . Particles of rock used as aggregate in the pavement.

  . Litter discarded by users of the parking area.

- Materials now imparted to storm waters will continue to be imparted to storm waters at the site in greater or lesser amounts, depending on the regularity of cleaning of the parking area, the method of cleaning, and the method of disposal of materials removed from the area.

Proper disposal of sweepings to land will prevent entry of sweepings to surface waters, whereas washing of accumulated materials into drains will transfer those materials into surface waters.

- Dry weather construction will raise a minor amount of dust, some of which would land in offshore waters affecting water quality. The impact of construction during the summer is considerably less than if construction extends into the rainy season at a time when runoff from unprotected soil surfaces, loosened during construction, could carry soil into offshore waters, causing substantial turbidity. (See Mitigation section, pages 53-54; for a full report, see Appendix K.)

(4) Fuel Oil Spills

There would be an adverse impact on water quality in the event of uncontained ferry fuel oil spillage.

The most toxic components of petroleum oils are found in the lighter fractions, such as light diesel oil. Studies following spills of different grades of oil have shown that with light diesel oil spills there is a high mortality of invertebrate populations independent of the smothering effects of crude oil.

Fuel (light diesel oil) for the ferries will be delivered to the terminal by barge or tank truck. Four storage tanks located in the southwest corner of the site will be surrounded by a berm that creates a basin of sufficient size to contain the fuel stored in case of tank failure and screens the tanks from view.

The risk of spills during delivery and during refueling operations will be minimized by the installation of metallic hoses and by the design of matched fittings on the ferry and the landing floats.

g. Noise Levels

There will be some noise impact resulting from increased car and bus traffic on east Sir Francis Drake Boulevard, parking lot activities, and the ferries themselves.

Against existing levels of traffic-generated noise at a position along Corte Madera Creek and another north of Sir Francis Drake Boulevard, the increase in noise generated by ferry traffic is rated "Some Impact" according to criteria in the National Cooperative Highway Research Program Report 117. Background noise levels in the terminal vicinity are expected to diminish when Hutchinson Quarry operations terminate, altering the ratio between background noise and ferry noise and increasing the impact rating.

A comparison of the existing and future noise levels caused by cars and buses moving in and out of the terminal parking lot and along east Sir Francis Drake Boulevard, based on estimated traffic volumes for 1975 and 1990 and interpreted on a basis of criteria specified in NCHRP Report 117, results in a rating of "Some Impact" on adjacent residential land.

Noise generated by the ferries themselves will have negligible impact on the adjacent lands. The increase predicted by the operation of two ferries per hour is 2 dBA; three ferries is 4 dBA. Compared with present ambient levels, this is considered a negligible impact on the environment. There will be an impact considered to be a transient response from any ferry whistles or fog horns used in the operation of the ferries.

See Appendix F for noise impact study.

h. Climate and Air Quality

There will be little impact on climate beyond a few thousand feet of the terminal.

There will be a net reduction of air contaminants, both in the terminal area and in the regional area.

The Larkspur Ferry Terminal project will have an almost undetectable effect on the climate at a distance beyond a few thousand feet of the site. Changed concentrations of contaminants in the air are too small to have a detectable effect on the climate. Changed surface charges such as the pavement in the parking area and the buildings will be unlikely to produce a temperature change of more than 1-2° F. directly over the site; and at a distance of one mile downwind, after typical dilution with surrounding air, a change of not more than 0.1-0.2° F.

The slight heating produced by the paving should be largely offset by the cooling resulting from deeper water channels after dredging.

Heat generated through the burning of fuels or space heating should not affect the air temperature, even over the site, by more than 0.2° F.

See Appendixes G and H for microclimate and air quality studies.

As shown in the tables below, the net effect of the ferry and terminal operations, as projected for 1990, is to reduce

the emission rate of each of the contaminants considered, both in the very small interchange area and in the total county and regional areas.

Table 1. Comparison of Emission Rates (lb/day) in Study Area.* **

Contaminant	1973 Estimates	1990 Projections With Ferry	1990 Projections No Ferry
Carbon Monoxide	8,764	2,105	2,126
Nitrogen Oxides	2,033	485	515
Hydrocarbons	6,640	2,287	2,462
Particulate Matter	100	38	41
Sulfur Oxides	60	72	73

* Primary study area, to which these figures apply, was a circle of one-half mile radius, centered on the interchange at Sir Francis Drake Boulevard and U.S. 101.

**Figures reflect increased emission control devices.

Table 2. Projected Reductions (lb/day) in 1990 through Ferry Operations.

Contaminant	Primary Study Area	Bay Area Region
Carbon Monoxide	21	168
Nitrogen Oxides	30	353
Hydrocarbons	175	2,048
Particulate Matter	3	38
Sulfur Oxides	1*	28*

* Based on sulfur content of 0.075% in fuel; some increase (rather than reduction) might be found if higher-sulfur fuel is used.

i. <u>Traffic</u>

<u>A major impact of the ferry project will be the possible removal of 1,600 cars daily from Highway 101 and the Golden Gate Bridge</u>.

<u>A short-term impact will be local traffic congestion</u>.

Traffic predictions for 1975 indicate that the ferry will remove 1,600 cars daily from commuting across the Golden Gate Bridge to San Francisco from Central Marin on Highway 101.

Traffic will be reduced in San Francisco.

The need for additional lanes for Highway 101 and the approaches in San Francisco will be reduced.

An alternate means of travel to San Francisco is available; for example, in case of earthquake damage to Highway 101 or to the bridge.

Localized traffic congestion will occur on east Sir Francis Drake Boulevard during commute hours. All westbound traffic leaving the parking area will be required to make a left turn across eastbound traffic on Sir Francis Drake Boulevard, although the amount of eastbound traffic is small during evening commuting hours. A lane occupancy controlled traffic signal is recommended for the parking lot entrance.

2. <u>Any Adverse Environmental Effects Which Cannot be Avoided</u>

The major unavoidable and adverse impact on the environment resulting from developing a ferry terminal facility at the Larkspur site is the extensive dredging of marsh and mud flat. The terminal site itself is not a rich area biologically, because of repeated filling and asphalt disposal. However, viewed in the light of

past extensive dredging, diking and filling around San Francisco Bay, the loss of 32.8 acres of marsh and mud flat caused by the creation of an approach channel and turnaround basin, is considered to be major, adverse and unavoidable. Other adverse impacts are considered to be short-term, or less significant to the environment.

3. Mitigation Measures Proposed to Minimize the Impact

Appropriate mitigation measures to counter adverse impacts generated by construction of a ferry terminal at Larkspur are described below. Mitigation of environmental impacts has been considered during the preliminary site layout and the master planning. The terminal facilities will essentially be constructed on land areas as opposed to building out over the water. Additional open water will be created to provide for berthing. Side slopes for the channels will extend back under the structures which will improve flushing action and will provide additional habitat for fish. In the areas where some Bay fill (consisting of pilings) is necessary for eventual development of commercial facilities, the fill will provide for improved pedestrian access to the Bay. The location and alignment of basin and approach channel have been planned to cause minimum disturbance to existing marshlands and mud flats and to conform to the natural water course.

a. Geology and Soil Factor Mitigations

(1) Earthquake and Settlement Design Considerations

Detailed engineering studies and analyses have been performed during the design phase of the terminal to evaluate earthquake effects and to design the project for minimal damage and low risk to life in even the most severe earthquake.

The property is superior to many Bay-front parcels because its soils, as a result of their grain size and density, are not susceptible to liquefaction and because the required water depths and consequent slope heights are moderate.

Slope angles were selected by the terminal designers partly on the basis of stability during earthquake. Tops of slopes are expected to move outward a few inches as a result of a large earthquake (Richter magnitude 7.0). A great earthquake (Richter magnitude 8.25) could shift the tops of slopes a few feet. In the latter case, there would be permanent deformation of the terminal and deck structures. The terminal facilities are designed with flexibility and compressible elements to accommodate all but great earthquakes, as well as the continued slow-rate creep of the slopes occurring independently of seismic activity. The designers are utilizing modern techniques to limit damage during a great earthquake to a repairable level--that is, without failure of the structures or deck.

The terminal and deck structures will be pile-supported for the obvious transition from land to water and also in consideration of the settlement which will occur over a period of years.

(2) Design of Approach Channel for Minimal Shoaling

A preliminary approach channel design has been selected for the project which combines the lowest rate of deposition with the highest rate of scouring action by the waters of Corte Madera Creek. Shoaling is affected by bends and irregularities

in the channel boundary; hence the straightest, most uniform channel will have the lowest and most uniform shoaling. The use of the existing channel of Corte Madera Creek provides a relatively straight water with attendant scouring action, and an established bank and shore to the north.

From the standpoint of shoaling, use of the Corte Madera Creek junction for turning is preferable to construction of a widened turning area. Avoidance of side slips and finger piers, and a gradual widening of the channel into the turning area will also minimize shoaling. Maintenance dredging will be required.

b. Visual and Noise Mitigations

(1) Proper Landscaping of the Terminal

Proper landscaping of the terminal will do much to mitigate the visual impact of the buildings. Some of the specific recommendations are as follows:

- Use of plant materials native to Marin County. Where natives cannot thrive under the specific site conditions of wind, spray, irrigation, auto exhaust fumes, reflected heat from paved surfaces, pedestrian traffic and saline subsoil, nonnative species visually resembling natives should be used.

- Use of mass plantings, especially in parking areas, in rather orderly rows with uniform spacings. Plantings will need to be raised 2-1/2 to 3-1/2 feet above the surrounding paving to provide a soil depth free of saline water intrusion.

- Consideration of maintenance problems of plants that have a heavy fruit drop or need frequent pruning or shaping. Needles on paving can be hazardous to pedestrians, as well as increase the biological oxygen demand level of water runoff.

- Location of trees to buffer cold wet winter winds.

- Confining intensely colored plants such as annuals to strategic locations, generally near the terminal and commercial facilities.

(2) Construction of a Berm

Construction of a berm between the parking lot and the State Lands marsh will significantly reduce both the visual and noise impact on Greenbrae Boardwalk residents, on boaters along Corte Madera Creek and on wildlife in the marsh.

(3) Regulation of Operational Noise

Operators of the ferry will be instructed to use the whistles as little as is consistent with safety.

c. Natural Habitat Preservation

(1) Restoration of Marsh Habitat from Presently Diked Lands

Loss of wildlife habitat can be mitigated by establishment of new habitat. While no interspecies population structure can ever be duplicated exactly, substantial replacement of habitat can and should be provided.

In view of the past extensive destruction of marshes and mud flats, no further losses of these habitats should be sustained without the establishment of at least equivalent marsh or mud flat. In the Corte Madera Bay ecosystem, the marshes have been extensively destroyed and, as has been stated earlier, these marshes provide the primary energy source--organic detritis--to the estuarine community. Salt marshes which have been diked off from tidal action can be reestablished, with proper adjustment of elevations, by opening them to tidal action.[29]

An appropriate mitigation to minimize the impact of losing the marsh vegetation and tidal mud flats within the

project area is the regeneration of salt marsh habitat elsewhere along the shores of Corte Madera Bay. At the time of writing this report (July 1973) it appears that the property known as the Muzzi property (see Figure 3) might become available for marsh restoration. The possibility exists also that the dredging spoils from the project might be used in the marsh regeneration process. This mitigation would involve only spoils from the initial dredging--not maintenance dredging. For a preliminary plan for land disposal of dredging spoils to be used in marsh reclamation, see Appendix L.

(2) Creation of a Channel and/or a Berm to Protect State Lands Marsh

Because the State Lands marsh adjacent to the ferry terminal site is a habitat for endangered species, it is recommended that a channel and/or a berm be built between the terminal site and the marsh area. A channel would not only protect the habitat of the California clapper rail, but would increase the flow of water to the inner portions of the marsh, provide feeding grounds for shore birds close to the site, where passengers could observe them, and perhaps create new marshland habitat in the area near Wood Island. A berm would provide less protection to the marsh but more to the Greenbrae boardwalk residents.

(3) Optimum Season for Dredging

The optimum season for dredging is during the summer months, June through September, for the following reasons:

- Migratory steelhead trout move up Corte Madera Creek to spawn from December to March.(30) Prolonged dredging in the mouth of Corte Madera Creek should be avoided during these months.

- Shore birds and waterfowl utilize the project area for resting and feeding from September through April.
- Oxygen content of the Bay is high in the summer because of the spring algal bloom; thus effects of turbidity would be offset.
- Water levels in Bay are lower in late summer from evaporation, decreased inflow and precipitation, and salinity levels are higher. These conditions would minimize any dredging effects by allowing for faster flocculation of sediments after dredging and a lowered rate of release of heavy metals.

(4) Protection of the Heerdt Marsh

The mud flat surrounding the northeast tip of the Heerdt marsh prevents wave damage to the first line of cord grass at mid-tide levels, because waves crest and break on this mud flat before reaching the plants. With the expected increase in wave action caused by the ferry, this mud flat will be essential in protecting the creek margin of the marsh, and should be left intact.

(5) Protection of San Quentin Shellfish Bed

The approach channel should be designed so that the shellfish bed on San Quentin peninsula is not damaged. This would involve preserving the present grade of the shoreline and channel slope. When the two adjacent sanitary districts comply with Regional Water Quality regulations regarding location of outfalls, clamming for softshell clams could again be permitted. This particular shellfish bed has excellent public access.

(6) Provisions for an Educational Nature Center

Because of the critical importance of mud flats and marshes to the Bay Area, the establishment of a nature center at the site is recommended. School children and tourists from San

Francisco could ride the ferry to Marin to enjoy the beauty of the marshes and learn of their role in the Bay-estuarine ecosystem. Local schools could use the facilities to carry out long-term studies on this marsh and mud flat.

(7) Provisions for Recreational Fishing

Provisions should be made at the terminal site for recreational fishing. Fishing will be improved in the terminal area by the dredging of a deeper channel and the use of pilings in the construction of the terminal facilities. Perch and other fish will be attracted to the rich assortment of pile-associated organisms such as worms and crustaceans.

d. Central Receiving Tank for Sewage

Sanitary District No. 1 is concerned about the possibility of a large number of taps into their pressurized main. They recommend that a master plan be developed which would utilize a central receiving tank for new local needs, in addition to the terminal project, and a single line to the plant or to the existing plant feed line.[31]

e. On-site Water Runoff

(1) Proper Cleaning of Parking Lot

Proper cleaning of the parking lot pavement surface can limit the material discharged from the site to offshore waters. Materials will be imparted to storm runoff at the site in amounts directly proportional to the amount of time that elapses between proper cleaning and/or rainfall of 0.1 inch or more.

(2) Treatment of Water Runoff

The quality of water runoff can also be improved by treatment of runoff prior to discharge into offshore waters.

Thirdly, runoff can be conveyed by pipeline to points in offshore waters which offer greater immediate dilution than that available near the shoreline.

(3) Construction Mitigations

To minimize pollution of water during construction, application of liquid palliatives, such as water or penetrating asphaltic materials, will control dust during dry weather grading, filling or cutting. During the rainy season, the construction specifications should stipulate that the contractor expose the smallest practical area of land subject to erosion at a given time. In addition, the specifications should require the construction of sediment basins to precipitate silt from storm runoff before it leaves the site, and the use of plastic sheets on surfaces susceptible to erosion.

(4) Fuel Oil Handling

Appropriate floating boom and firefighting equipment will be available in case of accidental spills. The spill will be contained and the oil removed from the water by portable equipment to prevent dissipation and the potential concomitant threat to marine life due to toxic effects. The tanks and piping systems are being designed to minimize emissions of hydrocarbons to meet Air Pollution Control District standards.

f. Need for Monitoring

The authors of this report urge the directors of the Bridge District to establish a monitoring program to be carried out on the project site.

During the course of investigations conducted for this impact study, it has become clear that the exact size and nature of impacts on the environment resulting from the development of a project such as the proposed ferry terminal are in many areas impossible to quantify. For some of these impacts, such as that on regional air quality, significant differences cannot be measured with present technology. In other areas, there is simply not sufficient background information to evaluate a project. Studies could include an air sampling station to be established on the site for a year--six months before the opening of the terminal and six months after; a continuing bird and invertebrate census; and a marsh regeneration study. These would be of great use in evaluating the environmental impact of other proposed developments on the shores of San Francisco Bay by the Bridge District.

4. Alternatives to the Proposed Project (Section 15243d)

Alternatives to the proposed Larkspur project are discussed below. The impacts of each alternative and of no project are compared with the impacts at the Larkspur site in the table, "Alternatives to the Proposed Action," following this page.

a. No Project Alternative

If no ferry project were carried out, there would be no reduction of peak hour congestion on Highway 101 or on the Golden Gate Bridge, where traffic is presently exceeding the bridge capacity for four lanes. Not building a terminal would necessitate an earlier decision for a rapid transit system using buses or a fixed guideway. All of these choices are costly and would require

considerable time until completion. A ferry located in mid-Marin also offers an alternative route to San Francisco in case of seismic damage to the Golden Gate Bridge. On the other hand, without a ferry project, the extensive dredging necessary to create an approach channel and turning basin would not be required. Because the Larkspur site is close to the Highway 101 corridor and already has been filled, it is likely that development of some sort will occur on the site in the event a ferry terminal is not built.

b. A Ferry Terminal Located on San Quentin Prison Grounds

From the beginning of this study until June 5, 1973, there was a possibility that the State of California might phase out the operation of the prison by mid-1974 and that land inside the prison might become available for the ferry terminal; however, on June 5, 1973, Raymond Procunier of the Department of Corrections wrote a letter stating conclusively that land inside the prison would not become available "in the immediate or foreseeable future."* Therefore, studies on Alternatives 2 and 3 on Figure 3 (sites within the prison grounds) were not actively pursued after this date. Preliminary facility designs, patronage figures and figures related to channel dredging have been included to aid in evaluating the scope of the project at each of the other alternative sites. For preliminary designs see Figures 10 and 11. Daily ferry patronage at the prison site was forecast to be 2272 commuters per day in 1975 with the existing access, and 2432 in 1975 with a new Highway

* Letter is attached as Appendix N.

ALTERNATIVES TO THE PROPOSED ACTION: SUMMARY OF IMPACTS AT THE PROJECT SITE AND AT ALTERNATIVE SITES

IMPACT	PROPOSED SITE Larkspur	San Quentin Village	San Quentin North	NO PROJECT
History and Archeology *	None--site is on filled marshland	The town (some houses from 1890's) would be virtually eliminated	None--the site is on filled marshland	No impact
Geology and Soils	Structures to be built on some bay mud fill--no new fill required	Piling construction for terminal; no new fill required for terminal; mechanical device for lowering and raising patrons to and from street and water levels	Piling construction for terminal; structures to be built on fill over bay mud; undetermined amount of fill for grading parking area	No impact
Seismic	A ferry terminal would provide alternate transportation if bridges incapacitated by earthquake	Same as Larkspur	Same as Larkspur	Lack of alternate form of transportatation
Visual	Project in view of Greenbrae Boardwalk houses, a few Greenbrae houses, east Sir Francis Drake Boulevard, boaters along Corte Madera Creek	Large parking structure would dominate San Quentin Village	Project in view of travelers on Highway 17 and boats in San Rafael Bay	
Vegetation and Wildlife *	Feeding grounds for 41 species of birds removed, including 32.8 acres of mud flat and a pickleweed island; channel may improve conditions for migrating fish; salt marsh and upland habitat on site with accompanying wildlife removed	Backyard vegetation and wildlife displaced; rocky shore habitat and accompanying wildlife covered by terminal facilities; migrating ducks and grebes displaced	24.1 acres of mud flat removed; rocky shore habitat with accompanying wildlife covered by terminal facilities; migrating ducks and grebes displaced	No impact
Socio-economic (1) Property condemnation	Site available	Condemnation of approximately 60% of village dwelling units with estimated assessed value of \$400,000 (Book 18, p. 16, Assessors Block 163)	Site acquisition required (Book 9, p. 16, Assessors Block 161; 9 or 10 parcels and two public utility easements)	Potential need for increased right-of-way for 101 for additional traffic lanes and interchanges
(2) Government Services — Police and Fire	City of Larkspur will provide	County jurisdiction with multiple protection provided by San Rafael police and fire depts. and Marin County sheriff and fire dept.	Same as San Quentin Village	

* A major impact on one or more sites

IMPACT	PROPOSED SITE Larkspur	San Quentin Village	San Quentin North	NO PROJECT
Public Utilities-- Sewer	A wet well collection point, a grease and oil separator and a lift station pump to the Sanitary District #1 facility will be required; secondary level treatment is provided	A connection to the San Quentin Village sewer maintenance will be required. The prison facility provides primary treatment to this district.	Present capacity sufficient; all of land within San Rafael Sanitation District boundaries	No impact
Public Utilities-- Water	90,000 gallons per day will be required; up-sizing of present main or a new tank for local usage (no existing tank in vicinity)	90,000 gallons per day will be required; no new installation	Up-sizing of present main or a new tank for local usage. No existing tank in vicinity	No impact
Noise	Increased levels for Greenbrae Boardwalk residents	Increased levels for remainder of village inhabitants	Increased levels for Rod and Gun Club	Additional noise to Greenbrae Boardwalk due to increased traffic on 101
Microclimate At site 1 mile downwind	Minimal < 1-2 degrees F. 0.1 - 0.2 degrees F.	Minimal	< 1-2 degrees F. 0.1 - 0.2 degrees F.	Increased highway traffic increases heat and nitrous oxides and potential smog occurrences
Air Quality	Reduction in highway traffic	Reduction in highway traffic	Reduction in highway traffic	No reduction in traffic; same pollution potential as above
Water Quality Storm runoff	Increase from present 1-15 cu. ft./sec.; pollutants would include petroleum derivatives, heavy metals and asphalt breakdown products	For roof parking: 20% accumulation of materials; for closed roof parking: substantially less	Same as for Larkspur	No impact
Off-shore sediment analysis	Samples from harbor area, turning basin and approach channel all exceeded RWQB limits for one or more of seven specified pollutants; approach channel spoils eligible for Alcatraz disposal; others, on land or in ocean	The same as approach channel at Larkspur, i.e., polluted with organics	None made, expected to be same as approach channel at Larkspur	

IMPACT	PROPOSED SITE: Larkspur	PROPOSED SITE: San Quentin Village	PROPOSED SITE: San Quentin North	NO PROJECT
Dredging[1,2]				
Channel Length -(ft.)	9,700	2,500-4,000	5,300	
Total Acreage to be Dredged				
(Channel Area-Acres)	67	17-28	36	
(Harbor Area-Acres)	16	12-28	17	
Approximate Dredging (cubic yards)	1,300,000	280,000 - 550,000	726,000	
Cost of Dredging [3]				
a. Land Disposal	$1,312,000	$671,000	--	
b. Land/Alcatraz	$1,530,000	$745,000	$840,000	
c. Alcatraz/Ocean	$2,080,000			
Breakwater Length (ft.)	0	900 - 1,300	0	
Tidal Mud Flat Area (-2.6 to +3 ft. mean sea level) that would be disturbed by dredging (acres)	32.8	0	24.1	
Total Dredge Area (acres) which is tidal mud flat	39.5%	0%	45.5%	
Total Corte Madera Tidal Mud Flat to be Dredged	3%	0%	2%	
Operating Time of Ferry to San Francisco (minutes)	35	33	35	
Commuter Patronage [4]				
% of commuters using ferry	17	Remote parking: 3 Adjacent " : 9	Existing access: 8 New highway interchange added: 12	
% of patronage at Larkspur site	--	Remote parking: 18 Adjacent " : 53	Existing access: 47 New highway interchange added: 71	
1975 Commuter Patronage Forecast (daily)	3,200	Remote parking: 576 Adjacent " : 1,696	Existing access: 1,504 New highway interchange added: 2,272	

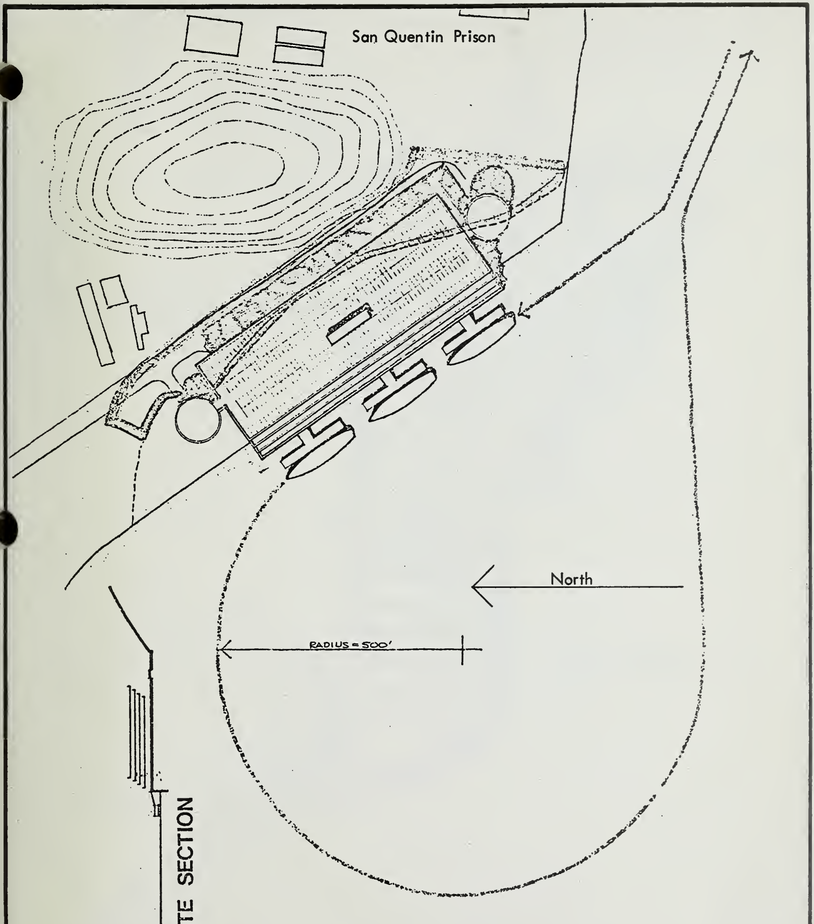
(1) Harbor and access channel dredged to -12 mean low low water for this comparison (Figures from Kaiser Engineers)
(2) Channel area based on top width of approximately 300 feet
(3) These figures are based on the following cost estimates per cubic yard: land-$1.20; Alcatraz-$1.35; Ocean (100 fathom line)-$2.85
(4) Relative Patronage Forecast for Alternate Sites of the Central Marin Terminal of the Golden Gate Bridge, Highway and Transportation District Ferry Service; revised May 14, 1973. Kaiser Engineers

IMPACT	PROPOSED SITE: Larkspur	PROPOSED SITE: San Quentin Village	PROPOSED SITE: San Quentin North	NO PROJECT
Traffic:				
Local Congestion	At peak commute times	At peak commute times in San Quentin Village and on and off Highway 17.	Evening parking lot congestion because of difficult entry onto Highway 17	Congestion on the Golden Gate Bridge and Highway 101
Roadway Modification Needed	Access intersection with east Sir Francis Drake Boulevard *	Eventual modification of San Quentin Interchange on Highway 17	Route 17 overpass will be required immediately	Additional lanes on Highway 101; modification of San Francisco bridge access routes

* Central Marin Ferry Terminal Traffic Analysis--prepared by Marin Balanced Transportation Program

DREDGING IMPACTS AT ALTERNATIVE SITES IN SAN QUENTIN PRISON

IMPACT	PRISON SITE #1	PRISON SITE #2
Dredging		
Channel length	7,600	5,700
Total acreage to be dredged		
Channel area (acres)	53	40
Harbor area (acres)	20	23
Approximate dredging (cu. yds.)	700,000	600,000
Cost of dredging		
Land disposal	$830,000	$725,000
Land/Alcatraz	$945,000	$810,000
Alcatraz/ocean		
Breakwater length (ft.)	450	300
Tidal mud flat area (-2.6 to +3 ft. mean sea level) that would be disturbed by dredging (acres)	24.2	19.4
Total dredge area which is tidal mud flat (acres)	33.2%	30.8%
Total Corte Madera tidal mud flat to be dredged	2%	1.7%



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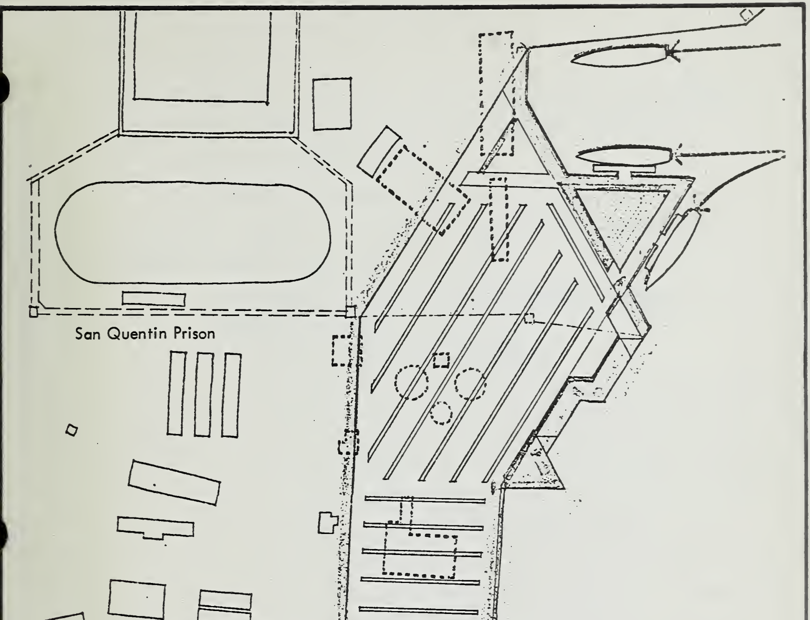
ALTERNATE SITE 2
SAN QUENTIN PRISON

FIGURE 10



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ALTERNATE SITE 3

SAN QUENTIN PRISON

FIGURE 11

17 interchange added. The former figure represents a 29 percent reduction of the Larkspur site estimate, and the latter, a 24 percent reduction (see Appendix A).

Dredging information for the two sites within the prison grounds is given in "Dredging Impacts at Alternative Sites in San Quentin Prison" following page 55.

c. A Ferry Terminal Located at San Quentin Village - Alternate Site #4

(1) Location and Existing Setting

Alternate Site #4 is in the Village of San Quentin about 1,200 feet east of the San Quentin prison complex and west of a pump house and State paint facility at the west end of the Richmond-San Rafael Bridge.(1) Nearly the entire village is on the west side of the quarter-mile-long main street leading from Highway 17 to the prison gate. All traffic to the main entrance of the prison must travel along this street. The tiny, unincorporated village has the appearance of a 19th century town and consists of some 35 homes, most of which are single-family dwellings nestled on a steep hillside. These houses all have spectacular views of San Francisco Bay.

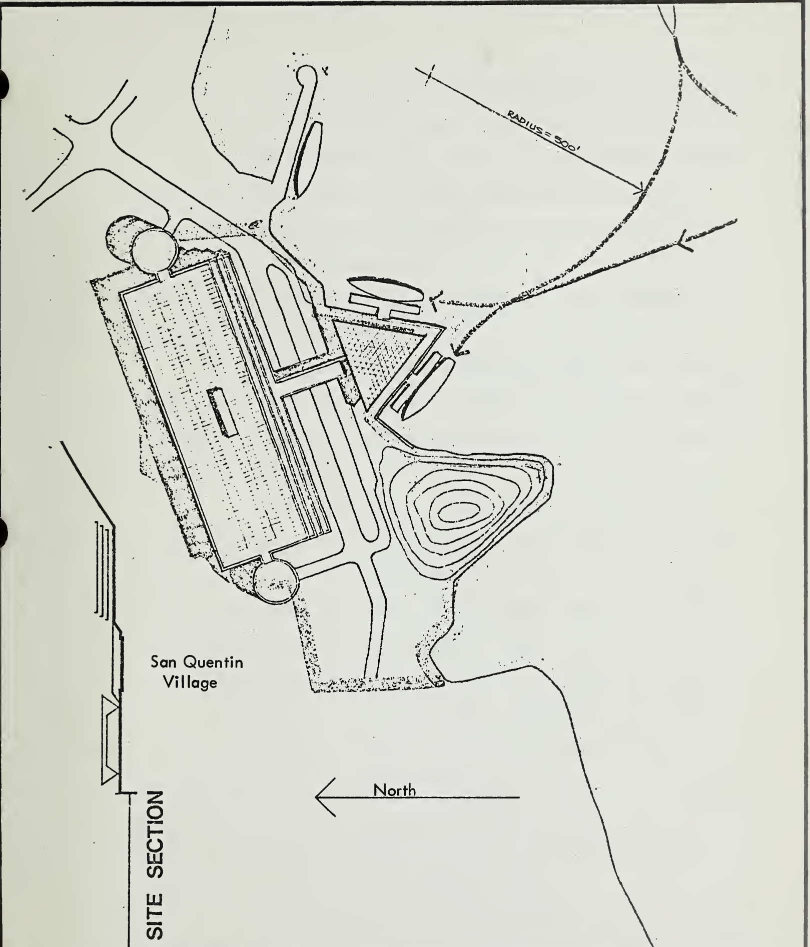
The village of San Quentin is rich in Indian and early Marin County lore. An Indian shell mound is registered (4-Mrn-79) at the junction of Route 17 and Sir Francis Drake Boulevard. Indian dwellings in this area were described by a number of observers in the 1800's. Several historians are working to determine whether Sir Francis Drake landed near Point San Quentin in 1579. Shortly after 1850, Benjamin Buckelow sold 20 acres of

land to the State of California for a prison and built a hotel on a bluff overlooking the Bay. His widow built a ferry terminal nearby and for many years the point was the chief route from San Francisco to the Marin County seat, San Rafael.

A small rocky promontory lies bayward of the main street. There are several windblown Monterey cypress and Monterey pines at the tip of the promontory, and the remainder is covered with assorted grasses, radish, thistle, sagebrush, poison oak--vegetation typical of disturbed areas. The rocky cliff edges have patches of flowers such as sedum, sticky monkeyflower, valarian and poppies. The beach, some 25 feet below the road, is rocky even at low tide and in June is abundantly covered with algae such as *Fucus*, *Ulva* and *Enteromorpha*. An abundance of invertebrates live in the substrate of the beach. A number of eucalyptus trees line the street.

(2) Discussion

Chief among the adverse impacts of establishing a ferry terminal at the San Quentin Village site is the removal of 20 homes, 12 of which are pre-1890 houses in order to construct a parking facility (see Figure 12). To obtain this property an extensive and perhaps drawn-out property condemnation program would be required. The present assessed value of the community is about $670,000. Village and prison traffic both use the narrow main street; thus, the arrival of 500 to 1,500 cars in peak commuter times would have a major impact on the remaining residents and the prison.



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ALTERNATE SITE 4
SAN QUENTIN VILLAGE

FIGURE
12

Modifications at the intersection of the off-ramp from Highway 17 and the two-lane street into San Quentin Village would be required to prevent traffic from backing up onto Highway 17. Congestion would occur with evening peak commuter traffic leaving the village, crossing under and entering Highway 17 via the frontage road. Accompanying increases in air pollutants would result which would minimize the net reduction of air pollution the alternative of a ferry provides.

The topography of the site requires some mechanical means of moving people from the lower deck of the parking structure over the access road and down to the boarding level of the terminal, a change of 25 or more feet.

Ferry patronage is projected to be 47 to 82 percent less at the San Quentin Village site than at the Larkspur site, depending on the location of the parking facility. Such reduced patronage would not serve to alleviate excessive traffic volume on the Golden Gate Bridge. Access time from the Upper Ross Valley to a terminal at San Quentin Village is forecast to be 10 minutes longer than to the Larkspur site. Automobile commuters would not be so aware of the option afforded them by a ferry terminal constructed at this site because it would be well hidden from Highway 101. In addition, commuters would not have the benefits of a integrated commuter bus and ferry feeder system such as would be feasible at the Larkspur site.

The principle advantage of the San Quentin Village site over Larkspur is that the initial amount of dredging required

at Point San Quentin is considerably less than at Larkspur; the channel would be approximately 25 to 40 percent shorter depending on the alignment; the total cubic yardage of dredging would range from 30 to 50 percent less. On the other hand, considerable maintenance dredging would be required because instead of coinciding with a natural waterway, as does the Larkspur channel, the channel would be perpendicular to the natural shoal line so that prevailing winds and currents would constantly carry silt into the channel. Because of the strong winds and currents at Point San Quentin, a breakwater of 900 to 1,300 feet would be required to shelter the docking facility.

d. <u>A Ferry Terminal Located at San Quentin North Site - Alternative Site #5</u>

(1) <u>Description</u>

The San Quentin North site is located on the north side of Point San Quentin on recently filled land.* To the south it is bordered by Highway 17 and its frontage road. Grading contractors, a debris box firm and a Sears Roebuck service center all occupy or use parts of the site. The edge of the fill along the Bay is retained primarily by rubble composed of broken concrete with many exposed steel reinforcing rods. At low tide a rocky shore, which in the spring and summer months is abundantly covered with the green algae, <u>Enteromorpha</u> and bits of <u>Ulva</u> is exposed. Areas presently utilized for parking and service yards are graded flat, but other areas are uneven and are covered with scattered broken construction material and fill of various types. A few trees, such as black acacia and Monterey pine, stand near

the buildings. Various grasses and weeds such as dock and anise grow sparsely around the edges of the site.

Views of the site from Highway 17 and its frontage road are limited because of the road elevation and shrubby highway planting. Views from the site to the east look across the Bay to Point San Pablo and the Richmond-San Rafael Bridge, with the Marin Islands and Point San Pedro in the background. To the northwest, portions of San Rafael and the San Rafael hills can be seen. The San Rafael city dump is on adjacent property. While the dump would not have an adverse effect on the well-being of passengers, it is not considered to be a quaint setting for a ferry.

(2) Discussion

The overall environmental impact of a ferry terminal project at this site would be far less than at the Larkspur site. No marshland would be destroyed; the initial amount of dredging would be less; ducks, grebes and the few shore birds using the rocky beach and open bay area would be displaced to a minimal degree by the terminal facility. There are, however, a number of operational difficulties here that must be taken into account.

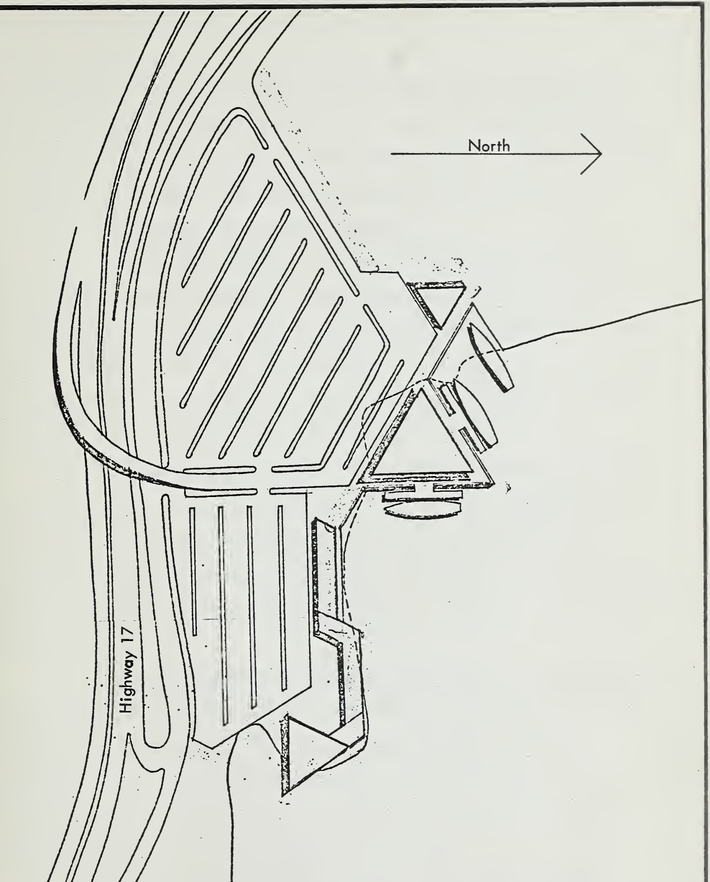
The Kaiser report estimates that patronage will be 29 to 53 percent less at this site than at Larkspur, depending on the parking lot access from Highway 17. (See Appendix A for patronage study.) Because of the design of the Richmond-San Rafael Bridge, ferries from a terminal at this site would be required to travel well out into the Bay to the bridge undercrossing. Estimated ferry travel time to San Francisco is the same as from Larkspur;

however, Ross Valley commuters would have an estimated 5 to 10 minutes of additional driving to the ferry parking area, assuming no intersection congestion.

An overpass on Highway 17 would be necessary to feed cars into the parking facility from San Rafael and the Ross Valley area (See Figure 13). Since the entire area is bay fill, a piling-type design would be required at an estimated cost of two to three million dollars. Parking lot circulation would be limited by the overhead access road which bisects the parking lot at the entrance. All cars and buses leaving the parking lot would have to double back 1,500 feet on the frontage road and make a difficult U-turn to get onto Highway 17. The resulting parking lot congestion predictably would contribute considerable quantities of pollutants to the air and thus reduce the net gain in air quality anticipated by installation of a ferry service alternative.

The San Quentin North site does not provide the visually obvious alternate means of travel to and from San Francisco to commuters on Highway 101; nor would it provide the flexible integration with commuter and ferry feeder buses that is anticipated at the Larkspur site. The area is too far for bicycle commuters to travel from the Ross Valley and, of course, does not tie into the possible residential development on the Hutchinson Quarry site, from which patrons could walk to the ferry terminal.

Studies by Kaiser Engineers indicate that the channel length required at the San Quentin North site would be slightly more than 50 percent of that required at Larkspur, with approximately 40 percent less dredging. Because the channel cut



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ALTERNATE SITE 5

SAN QUENTIN NORTH

FIGURE
13

lies perpendicular to the natural shoal line, much greater maintenance dredging is anticipated at this site, which would offset the initial gain. The dredging will remove 24.1 acres of mud flats; the terminal structures are on piles over existing open water.

e. Summarization of Alternatives

There are different factors to be weighed with each possible alternative. With no ferry project, traffic congestion will continue to increase, requiring both earlier action on a rapid transit system, as well as improvements in the present Golden Gate corridor. These improvements include additional lanes on Highway 101 and on the bridge approaches in San Francisco.

At the Larkspur site, the extensive dredging of 32.8 acres of mud flat and salt marsh will have a major adverse impact without the mitigation of creating new tidal marshlands. The Larkspur site would attract the largest patronage and offers the possibility of a flexible bus-ferry commute system by its proximity to Highway 101.

The San Quentin Village site virtually eliminates the entire village to provide parking facilities. Patronage is estimated to be approximately 50 percent less than at Larkspur. A facility at San Quentin Village would require two-thirds less dredging than at Larkspur, but a breakwater would be required which would have an adverse impact on the Bay.

The San Quentin Village site with remote parking (e.g., at the San Quentin North site) would attract relatively little patronage; therefore, it would not provide substantial relief to the transportation corridor.

At the San Quentin North site, a highway overpass would be required immediately. Patronage is estimated to be 70 percent of that at Larkspur. Dredging is estimated to be a little more than 50 percent of that at Larkspur, but extensive shoaling would probably require more frequent maintenance dredging. There should be some mitigation of this dredging also. It does not offer the flexible commuter system of Larkspur because of its distance from Highway 101.

In summary, the Larkspur site offers the maximum patronage and flexibility of service even though it would require the largest amount of dredging with the accompanying environmental damage.

5. The Relationship Between Local Short-term Uses of Man's Environment and the Maintenance and Enhancement of Long-term Productivity (Section 15143e)

The significant relationship to be considered in the proposed project is that of short-term reduction of traffic congestion on Highway 101 and the Golden Gate Bridge, versus the extensive dredging of salt marsh and mud flat resulting in a long-term loss of productivity to the Bay ecosystem.

The immediate need in Marin and Sonoma Counties is for relief from traffic congestion on the Golden Gate corridor during commute hours. In the sense that the project is concerned with traffic for this generation of man or even the next several generations, it is considered to be a short-term use of the environment when weighed against the long-term productivity of

the Bay ecosystem, a system that has functioned for millions of years. The loss of such extensive amounts of mud flats and bottom sediments and a small amount of marsh is thus significant, even though it represents a small percentage of the total, since these resources have been so depleted in the past. Restoration of tidal marshland, the primary source of energy in the Bay ecosystem, would compensate for the loss of mud flat. This is particularly true in Corte Madera Bay where the acreage of marshland is small relative to the acreage of mud flat.

6. Any Irreversible Environmental Changes Which Would Be Involved in the Proposed Action Should It Be Implemented (Section 15143f)

Construction of terminal facilities on the site commits the 25-acre site to human use rather than to open space for wildlife. At present the site is an area of fill and patches of asphalt spoils, and thus of marginal use to wildlife; however, it is not actively "used" by man and so can be regarded as poor quality open space. The increased traffic at commuter hours probably will require future improvements to east Sir Francis Drake Boulevard and possibly to the Highway 101 interchange. The dredging operation will remove a pickleweed island, an extensive portion of mud flat and bottom sediments for the channel. Without maintenance dredging, shoaling might well replace the bottom sediments and even create new tidal mud flat; however, it is unlikely that once dredged, the pickleweed marsh would reform by natural means in this area.

7. The Growth-Inducing Impact of the Proposed Action (Section 15143g)

In that 1975 traffic congestion will be reduced by an anticipated 1600 cars daily, making the commute for others more pleasant, the project could be considered as growth-inducing. It must be pointed out, however, that the Golden Gate Bridge peak hour capacity is currently being exceeded and that the maximum capacity for each of the two ferries scheduled to begin operation is 750 passengers. Thus, there will not be a significant reduction below the capacity of four lanes on the bridge. Planning controls by other agencies will affect significantly the growth rates; therefore, this project should be considered as accommodating growth rather than promoting it.

Development of the Hutchinson Quarry property is being planned to complement the ferry operation at Larkspur; however, it is presumed that this land would not remain undeveloped even though no terminal were constructed at this site.

CONCLUSION

The construction of a ferry terminal in central Marin County is an important segment of the combined transit system required to provide for needs in the Golden Gate traffic corridor. Alternative sites have been evaluated to determine their relative environmental effects. The analysis showed that the use of each site would create some adverse impacts; these impacts were quantified insofar as possible. However, judgment of the relative weights of the significant factors have to be made without a precise scale of measurement.

After analysis of the detailed studies of the significant environmental factors involved, it is concluded that the Larkspur site is an appropriate location for the ferry terminal; various means of mitigating the losses to the local environment have been established. Adoption of the land disposal scheme for dredge spoils for salt marsh regeneration would create an environmental asset not otherwise attainable in the near future.

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ORGANIZATIONS AND PERSONS CONSULTED IN THE PREPARATION OF THIS REPORT (Section 15144)

This report has been prepared by Madrone Associates, as part of a planning and design team headed by Braccia/DeBrer/Heglund. Other members of the design team are Kaiser Engineers; Harding-Lawson Associates; Royston, Hanamoto, Beck and Abey; Larry Smith and Company; and Towill, Inc.

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JHK & Associates

Shoaling Study:

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The figures in this report were prepared by the design team headed by Braccia/DeBrer/Heglund.

APPENDIXES

A. Relative Patronage Forecast for Alternative Sites of the Central Marin Terminal of the Golden Gate Bridge, Highway and Transportation District Ferry Service. Revised May 14, 1973. Kaiser Engineers

B. The Heerdt Marsh: Map and Plant Species List

C. Historical and Archaeological Survey of the Proposed Larkspur Ferry Terminal, Larkspur, California

D. Biological Assessment of the Proposed Larkspur Ferry Terminal

E. Sediment and Water Quality Analyses

F. Noise Impact Study

G. Air Quality Impact Study

H. Potential Impact on Microclimate

I. Traffic Impact of the Larkspur Ferry Terminal

J. Preliminary Evaluation of Shoaling at the Larkspur Ferry Terminal

K. Impacts of Larkspur Ferry Terminal Parking Facility on Water

L. A Preliminary Plan for Land Disposal of Dredging Spoils from the Larkspur Ferry Terminal to be used in Marshland Reclamation of the Corte Madera Diked Marsh Known as the Muzzi Property

M. Historical and Archaeological Survey of the Proposed Ferry Terminal Site at Point San Quentin, California

N. Letter of 5/15/73 from R. K. Procunier, Director of Corrections, State of California, to Hon. Peter H. Behr, Senator, 4th Dist., California, re availability of San Quentin Prison sites (Alternate Sites #2 and #3)

A. DESCRIPTION OF PROJECT

(Section 15141)

RELATIVE PATRONAGE FORECAST

FOR ALTERNATIVE SITES OF THE

CENTRAL MARIN TERMINAL

of the

GOLDEN GATE BRIDGE, HIGHWAY AND TRANSPORTATION DISTRICT

FERRY SERVICE

Revised May 14, 1973

KAISER ENGINEERS

The preparation of this report has been financed in part through a grant from the U. S. Department of Transportation, Urban Mass Transportation Administration under the Urban Mass Transportation Act of 1964, as amended.

Summary

This report presents patronage forecast information for comparison of a ferry terminal site at Larkspur with three terminal sites in the vicinity of Point San Quentin. The forecast indicates a relative patronage reduction from the Larkspur terminal site ranging from 24% to 82% depending on the terminal site and access assumptions.

The patronage forecasts are based on the patronage attractiveness of the terminal sites as related to access travel time. Other factors concerning the terminal sites such as cost, development potential, and environmental impact are not within the scope of this report.

The analysis and data in this report is based on the report Modal Choice Curves for Predicting Ferry Boat, Bus, and Auto Commuters in the Golden Gate Corridor, prepared by Peat, Marwick, Mitchell & Co. in July 1971, and on the work done in the Marin Balanced Transportation Program.

Ferry Terminal Sites

Ferry patronage forecasts are presented in this report for a ferry terminal site at Larkspur, a site within San Quentin Prison property, a site at Point San Quentin and a site on the north side of San Quentin Peninsula on San Rafael Bay (Figure 1).

The Larkspur site, at the mouth of Corte Madera Creek, is the site selected for the ferry terminal by the Golden Gate Bridge, Highway and Transportation District (GGBHTD). This site serves as the baseline case for comparison with the other sites.

The San Quentin Prison site is in the western portion of the prison property. Access would be through the west gate on Sir Francis Drake East Boulevard. Two patronage forecasts have been estimated for this site. One forecast assumes existing highway access and the second assumes a major highway interchange providing access from Highway 17 to Sir Francis Drake East Boulevard.

The site at Point San Quentin is south of the San Rafael-Richmond Bridge. This site does not have adequate space for smooth traffic access and parking. Two patronage forecasts have been made for this site. One forecast assumes a remote parking lot in the fill area north of the bridge, with a shuttle bus operating between the parking lot and the ferry terminal, and the second forecast assumes a parking lot adjacent to the ferry terminal either on bay fill or on a leveled area on the hill west of the terminal.

The last site, referred to as the San Rafael site, is in the fill area on San Rafael Bay on the north side of San Quentin peninsula. Two patronage projections have been made for this site also. One projection assumes present highway access which requires traffic to use the under-crossing at San Quentin for access to the site, and the second projection assumes a major highway interchange providing direct access to the terminal site from Highway 17 and Sir Francis Drake East Boulevard.

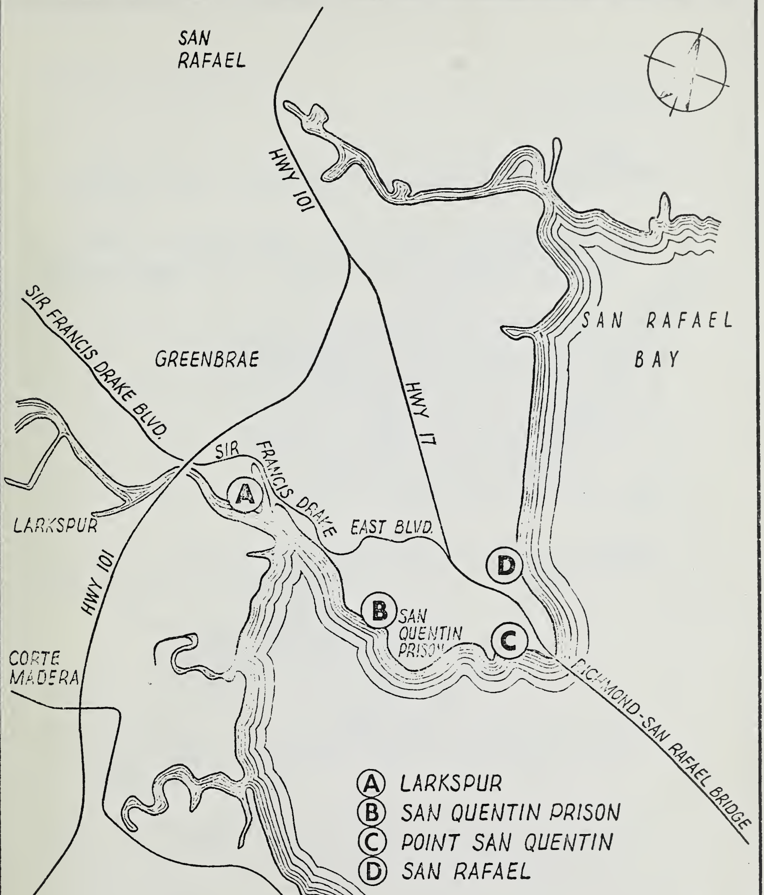


Figure 1

FERRY TERMINAL SITES

Figure 2

MARIN ORIGIN ZONES

Assumptions and Data Sources

The patronage projections were based on the following assumptions and data:

Marin Origin Zones: Five planning areas of the Marin County Balanced Transportation Program (Figure 2) were used as the origin zones feeding into the central Marin ferry terminal.

San Francisco Destination Zone: One San Francisco destination zone for the central business district (Figure 3) is assumed for this study. (This zone, surrounding the ferry terminal, includes the Optimum Bus Study zones 21, 22, 23, 24, 393, 394, 395, 396, 401 and 402.)

Modal Choice Curve: The modal choice curve for projecting ferry usage (Figure 4) was developed by Peat, Marwick, Mitchell & Co., and is presented in their report Modal Choice Curves for Predicting Ferry Boat and Auto Commuters in the Golden Gate Corridor, dated July 1971. The curve projects the percent of ferry patronage for a given ferry to auto travel time ratio. The curve was calibrated to fit the Sausalito ferry patronage experience as determined by 1971 origin and destination data. The travel time ratio is adjusted by a ratio of the time spent on the boat to access and egress time. This adjustment accounts for the heavy patronage of commuters living near to the ferry terminal and the desirability of spending time on the boat rather than in driving to the terminal.

Auto Trip Time (ATT): The total door-to-door trip times from the Marin origin zones to the San Francisco CBD were taken from the Marin Balanced Transportation Plan. These times are:

58 minutes from Lower Ross Valley
69 minutes from Upper Ross Valley
66 minutes from San Rafael
68 minutes from Terra Linda
76 minutes from Novato

Ferry Trip Time (FTT): The total door-to-door trip time via the ferry is the sum of the Ferry Access Time (AT), the Ferry Headway Wait (FH), the Ferry Line Haul Time (FHLT), the Egress Time (ET), and an Access Time Penalty (AP).

Ferry Access Time (AT): The access time from each origin zone to the Larkspur site was taken from the Marin County Balanced Transportation Program. These times are based on home to ferry terminal time via auto travel. The times to the Larkspur site were adjusted for the other ferry terminal sites, taking into consideration the road network and parking assumptions.

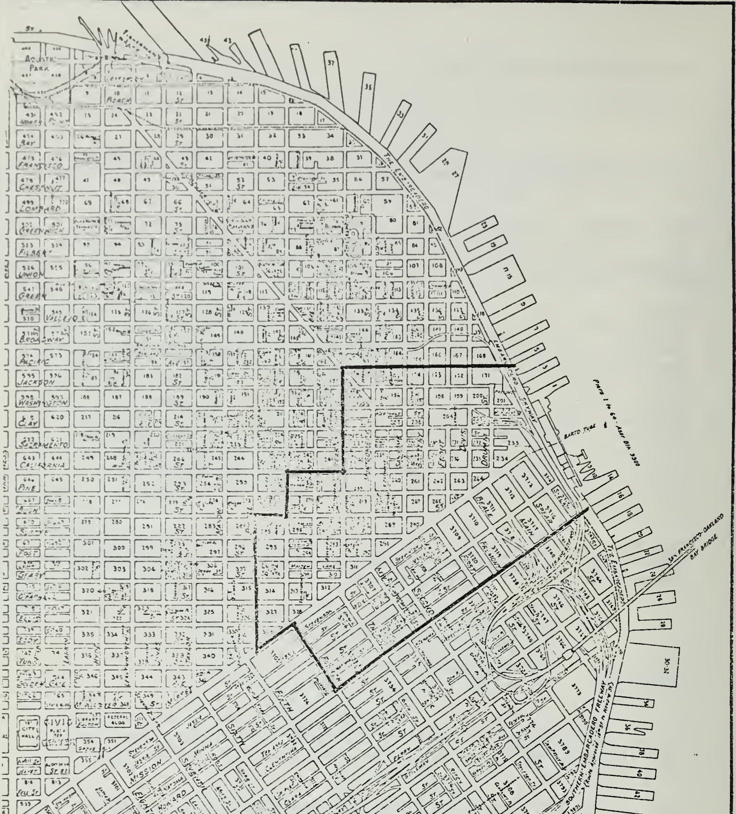


Figure 3

SAN FRANCISCO DESTINATION ZONE

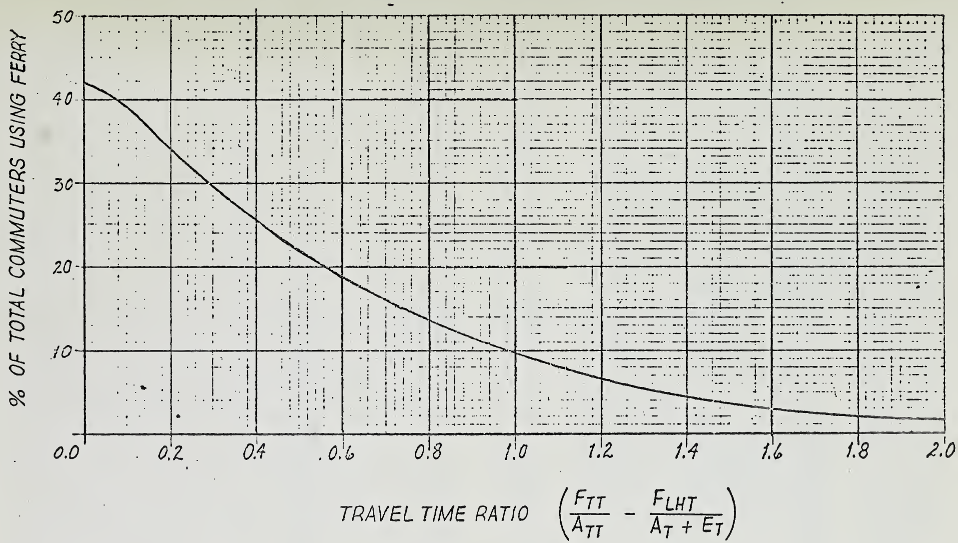


Figure 4

MODAL CHOICE CURVE

Ferry Headway Wait (FH): The assumed average passenger wait for a ferry was 15 minutes which is based on a 30-minute ferry headway. This is the same time as was used in the calibration of the modal choice curve (Figure 4), and in the Marin County Balanced Transportation Program.

Ferry Line Haul Time (FLHT): The line haul time includes loading time, cast-off, maneuver, acceleration, cruising time, deceleration, docking, and unloading. The line haul time from San Francisco used for the Larkspur site is 35 minutes. This time is based on the 1970 Spaulding and Associates' Report and is the time used in the Marin County Balanced Transportation Program. The line haul time for the other terminal sites was taken as the Larkspur time adjusted to take into consideration the shorter travel distance at a speed of 25 knots. The ferry trip from the San Quentin Prison site would be two minutes less, the Point San Quentin ferry trip would be six minutes less, and the San Rafael trip would be three minutes less than the Larkspur trip. Some early reports assumed a 45-minute ferry line haul time to the Larkspur terminal based on a reduced speed of the ferry in the channel approach to the terminal. However, current plans and data on the boat and the channel indicate that a reduced speed in the channel is not required.

Egress Time (ET): The egress time in San Francisco is the travel time from the ferry terminal to final destination. Fifteen minutes was assumed as the average egress time within the CBD zone, which is the same time used in the Marin County Balanced Transportation Program.

Access Penalty (AP): Based on the findings of the Marin County Balanced Transportation Program and analysis of data of the Sausalito ferry patronage experience, Peat, Marwick, Mitchell & Co., used an access transfer penalty of $2\frac{1}{2}$ times the auto feeder time in the calibration of the modal choice curve. (The appropriateness of relating the Sausalito data to the Central Marin Terminal is discussed under "Analysis of Patronage Projections", Page 14.)

Percent of Commuters from each Origin Zone (Z): The distribution of commuters from the five Marin Origin zones is based on data from the 1968 Optimum Bus System Origin and Destination Survey.

1975 Ferry Patronage Forecast for the Larkspur Terminal Site: The latest projections figure being used by the GGBHTD for the Larkspur Ferry Terminal site is 3200 commuters for 1975. This figure comes from the March 29, 1972 Technical Memo of JHK & Associates to the GGBHTD concerning ferry patronage estimates. This Technical Memo adjusts the results of the modal choice curve developed by Peat, Marwick, Mitchell & Co., which were based on travel time, to reflect more frequent ferry service related to the desired arrival time of workers commuting to San Francisco. The results presented in the Technical Memo increase the forecast based on the modal choice curves, which were developed from data derived from experience in the Sausalito ferry service which had $1\frac{1}{4}$ hour headways. The Memo analysis indicates the forecasts should be increased by 66% if headways are decreased to $\frac{1}{2}$ hour.

Patronage Forecast for the Alternative Ferry Terminal Sites

Relative patronage forecast for the four alternative ferry terminal sites are presented in Tables 1, 2, 3, and 4. The modal choice forecast for the Larkspur site (Table 1) is the same as developed in the Marin County Balanced Transportation Program.

Based on these relative patronage forecasts and the projection of 3200 daily commuters for the Larkspur site, commuter patronage forecasts for all terminal sites are as follows:

	Percent of Commuters Using Ferry	Percent Reduction from Larkspur Site	1975 Commuter Patronage Forecast
Larkspur Site	17%	-	3200
San Quentin Prison Site			
Existing Highway Access	12%	29%	2272
New Highway 17 Interchange Added	13%	24%	2432
Point San Quentin Site			
Remote Parking	3%	82%	576
Adjacent Parking	9%	47%	1696
San Rafael Site			
Existing Highway Access	8%	53%	1504
New Highway 17 Interchange Added	12%	29%	2272

Analysis of the Patronage Forecasts

The modal choice curve which is based on choice of patrons of the Sausalito ferry, is sensitive to increases in access time to the ferry terminal. As a consequence, the projections show a substantial reduction in ferry patronage for the San Quentin Prison, Point San Quentin and San Rafael terminal sites, especially from the Lower Ross Valley area, since access times are increased for these sites.

The appropriateness of relating the Sausalito data to the central Marin terminal appears justified. Even though the Lower Ross Valley does not have the high density, low walking distance relationship to the Larkspur site as Sausalito does to its ferry terminal, there is a great potential for bicycle access, a short "kiss and ride" access, and a potential for residential development within walking distance of the Larkspur terminal. Accordingly, the Lower Ross Valley has a much closer relationship to the Larkspur terminal than the other sites. With the latter sites, all areas including the Lower Ross Valley become similar to the relationship of the Mill Valley area to the Sausalito ferry terminal, which has experienced a very low patronage relationship. Thus, even though the high estimates for the Lower Ross Valley use of the Larkspur ferry contrast with the relative low estimates for the other sites, this seems valid.

The close relationship of the Larkspur ferry terminal site to the other commuter transportation systems gives additional optimism to this site which is not reflected in the patronage forecast and is not present with the other terminals sites including the Sausalito terminal. With the Larkspur site, commuters driving on Highway 101 or Sir Francis Drake Boulevard will have a greater awareness of the ferry system and are more likely to make a spontaneous decision to ride the ferry, especially if Highway 101 traffic is especially heavy. There is also the potential with the Larkspur site for ferry passengers to "catch a ride" to the terminal from neighbors commuting to places other than the San Francisco CBD since it will be easy and quick to "drop off" a rider from Highway 101 or Sir Francis Drake Boulevard at the Larkspur terminal. The Larkspur ferry terminal site also will be able to interact with the Golden Gate Bus System. Commuters will have the opportunity to park their autos and take the bus for the trip to San Francisco and the ferry for the return or vice versa. The collector service of the commuter bus system and the ferry feeder system could also be combined to provide better service for both systems.

Table 1

RELATIVE PATRONAGE FORECAST FOR
LARKSPUR FERRY TERMINAL SITE

		Marin Origin Zones					
		Lower Ross Valley	Upper Ross Valley	San Rafael	Terra Linda	Novato	All Zones
Auto Trip Time to SF	(ATT)	58 min.	69 min.	66 min.	68 min.	76 min.	
Ferry Access Time	(AT)	10	20	15	17	25	
Access Penalty ($2\frac{1}{2}$ AT)	(AP)	25	50	38	42	62	
Ferry Headway Wait	(FH)	15	15	15	15	15	
Ferry Line Haul Time	(FLHT)	35	35	35	35	35	
Egress Time in SF	(ET)	15	15	15	15	15	
Ferry Trip Time to SF	(FTT)	100	135	118	124	152	
FTT/ATT		1.72	1.96	1.78	1.82	2.00	
FLHT/(AT & ET)		1.40	1.00	1.16	1.09	0.87	
FTT/ATT-FLHT/(AT & ET)		0.32	0.96	0.62	0.73	1.13	
Percent of Commuters from the Zone Using Ferry, (Z)		29%	11%	18%	15%	8%	
Percent of Total Commuters from the Zone, (T)		22%	21%	19%	22%	16%	100%
Percent of Total Commuters Using Ferry, (ZT)		6.4%	2.3%	3.4%	3.3%	1.3%	17%

Table 2

RELATIVE PATRONAGE FORECAST FOR
SAN QUENTIN PRISON FERRY TERMINAL SITE

		Marin Origin Zones					
CALCULATION FOR EXISTING HIGHWAY ACCESS		Lower Ross Valley	Upper Ross Valley	San Rafael	Terra Linda	Novato	All Zones
Auto Trip Time to SF	(ATT)	58 min.	69 min.	66 min.	68 min.	76 min.	
Ferry Access Time	(AT)	12	22	17	19	27	
Access Penalty	(AP)	30	55	43	47	67	
Ferry Headway Wait	(FH)	15	15	15	15	15	
Ferry Line Haul Time	(FLHT)	33	33	33	33	33	
Egress Time in SF	(ET)	15	15	15	15	15	
Ferry Trip Time to SF	(FTT)	105	140	123	129	157	
FTT/ATT		1.81	2.03	1.86	1.90	2.07	
FLHT/(AT & ET)		1.22	0.89	1.03	.97	.78	
FTT/ATT-FLHT/(AT & ET)		.59	1.14	.83	.93	1.29	
Percent of Commuters from Zone Using Ferry, (Z)		19%	8%	13%	11%	6%	
Percent of Total Commuters from the Zone, (T)		22%	21%	19%	22%	16%	100%
Percent of Total Commuters Using Ferry, (ZT)		4.2%	1.7%	2.5%	2.4%	1.0%	12%
CALCULATIONS FOR HWY. 17 AND EAST SIR FRANCIS DRAKE BOULEVARD INTERCHANGE							
Ferry Access Time	(AT)	12 min.	22 min.	16 min.	18 min.	26 min.	
Access Penalty	(AP)	30	55	40	45	65	
Ferry Trip Time to SF	(FTT)	105	140	119	126	154	
FTT/ATT		1.81	2.03	1.80	1.85	2.02	
FLHT/(AT & ET)		1.22	0.89	1.06	1.00	.80	
FTT/ATT-FLHT/(AT & ET)		.59	1.14	.74	.85	1.22	
Percent of Commuters from Zone Using Ferry, (Z)		19%	8%	15%	13%	7%	
Percent of Total Commuters from the Zone, (T)		22%	21%	19%	22%	16%	100%
Percent of Total Commuters Using Ferry, (ZT)		4.2%	1.7%	2.9%	2.9%	1.1%	13%

Table 3

RELATIVE PATRONAGE FORECAST FOR

POINT SAN QUENTIN FERRY TERMINAL SITE

	Marin Origin Zones					
CALCULATION FOR REMOTE PARKING AREA	Lower Ross Valley	Upper Ross Valley	San Rafael	Terra Linda	Novato	All Zones
Auto Trip Time to SF (ATT)	58 min.	69 min.	66 min.	68 min.	76 min.	
Ferry Access Time (AT)	23	33	24	26	34	
Access Penalty ($2\frac{1}{2}$ AT) (AP)	57	82	60	65	85	
Ferry Headway Wait (FH)	15	15	15	15	15	
Ferry Line Haul Time (FLHT)	29	29	29	29	29	
Egress Time in SF (ET)	15	15	15	15	15	
Ferry Trip Time to SF (FTT)	139	174	143	150	178	
FTT/ATT	2.39	2.52	2.16	2.20	2.34	
FLHT/(AT & ET)	0.76	0.60	0.74	0.70	0.59	
FTT/ATT-FLHT/(AT & ET)	1.63	1.92	1.42	1.50	1.75	
Percent of Commuters from Zone Using Ferry, (Z)	3%	2%	4%	4%	2%	
cent of Total mmuters from the Zone, (T)	22%	21%	19%	22%	16%	100%
Percent of Total Commuters Using Ferry, (ZT)	0.7%	0.4%	0.8%	0.9%	0.3%	3%
CALCULATION FOR ADJACENT PARKING AREA						
Ferry Access Time (AT)	15 min.	25 min.	16 min.	18 min.	26 min.	
Access Penalty (AP)	37	62	40	45	65	
Ferry Total Time to SF (FTT)	111	146	115	122	150	
FTT/ATT	1.91	2.11	1.74	1.79	1.97	
FLHT/(AT & ET)	0.96	0.72	0.93	0.87	0.74	
FTT/ATT-FLHT (AT & ET)	0.95	1.39	0.81	0.92	1.23	
Percent of Commuters from Zone Using Ferry, (Z)	10%	5%	14%	10%	6%	
Percent of Total Commuters from the Zone, (T)	22%	21%	19%	22%	16%	100%
Percent of Total Commuters Using Ferry, (ZT)	2.2%	1.0%	2.7%	2.2%	1.0%	9%

Table 4

RELATIVE PATRONAGE FORECAST FOR
SAN RAFAEL FERRY TERMINAL SITE

		Marin Origin Zones					
CALCULATION FOR EXISTING HIGHWAY ACCESS		Lower Ross Valley	Upper Ross Valley	San Rafael	Terra Linda	Novato	All Zones
Auto Trip Time to SF	(ATT)	58 min.	69 min.	66 min.	68 min.	76 min.	
Ferry Access Time	(AT)	16	26	18	20	28	
Access Penalty ($2\frac{1}{2}$AT)	(AP)	40	65	45	50	70	
Ferry Headway Wait	(FH)	15	15	15	15	15	
Ferry Line Haul Time	(FLHT)	32	32	32	32	32	
Egress Time in SF	(ET)	15	15	15	15	15	
Ferry Trip Time to SF	(FTT)	118	153	125	132	160	
FTT/ATT		2.03	2.21	1.89	1.94	2.10	
FLHT/(AT & ET)		1.03	0.78	0.96	0.91	0.74	
FTT/ATT-FLHT/(AT & ET)		1.00	1.43	0.93	1.03	1.36	
Percent of Commuters from Zone Using Ferry, (Z)		10%	4%	11%	9%	5%	
Percent of Total Commuters from the Zone, (T)		22%	21%	19%	22%	16%	100%
Percent of Total Commuters Using Ferry, (ZT)		2.2%	0.8%	2.1%	2.0%	0.8%	8%
CALCULATION FOR DIRECT ACCESS FROM HWY. 17 AND EAST SIR FRANCIS DRAKE BOULEVARD							
Ferry Access Time	(AT)	14 min.	24 min.	15 min.	17 min.	25 min.	
Access Penalty	(AP)	35	60	37	42	62	
Ferry Trip Time to SF	(FTT)	111	146	114	121	149	
FTT/ATT		1.91	2.11	1.72	1.77	1.97	
FLHT/(AT & ET)		1.10	0.82	1.06	1.00	0.80	
FTT/ATT-FLHT/(AT & ET)		0.81	1.29	0.66	0.77	1.17	
Percent of Commuters from Zone Using Ferry, (Z)		13%	5%	18%	15%	8%	
Percent of Total Commuters from the Zone, (T)		22%	21%	19%	22%	16%	100%
Percent of Total Commuters Using Ferry, (ZT)		2.9%	1.0%	3.4%	3.3%	1.3%	12%

B. DESCRIPTION OF ENVIRONMENTAL SETTING

(Section 15142)

Appendix B

THE HEERDT MARSH

THE HEERDT MARSH

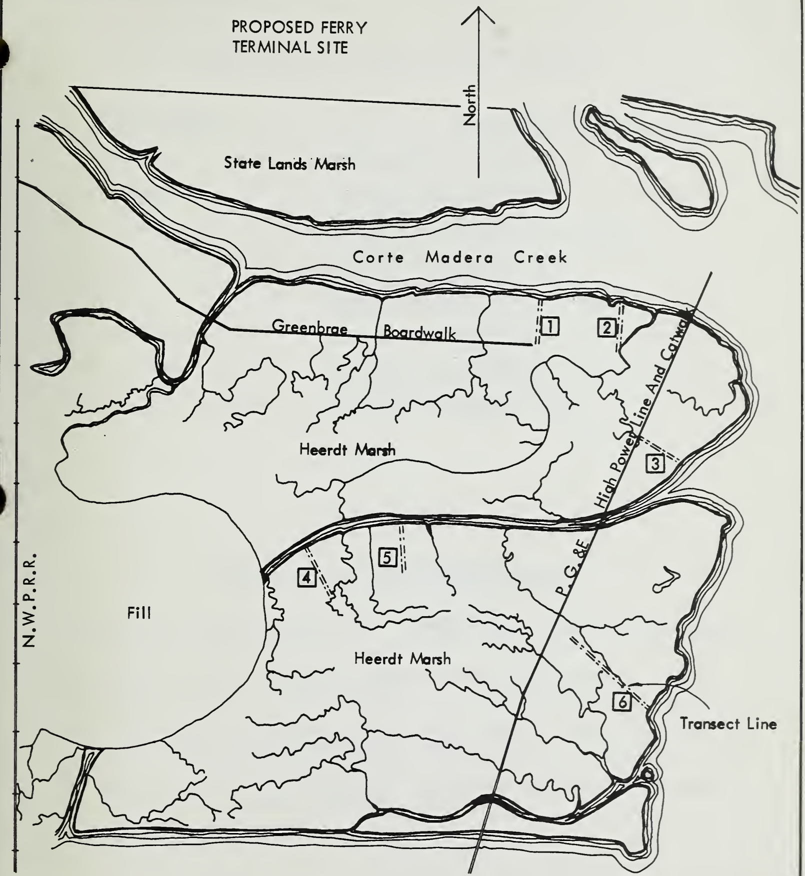
Vegetation analyses were made from data gathered along six belt transects varying in length from 200 to 340 feet by 3 feet in width; these transects were selected to cut across zones of vegetation from lower cord grass to upper pickleweed. Locations of the six transects are shown on Figure B1, following this page.

A complete list of plant species found on the Heerdt Marsh follows Figure B1. In general, plant cover consists of cord grass, pickleweed and salt grass, in the proportions shown below.

Cover Classes of Dominant Plants
on Six Transects on Heerdt Marsh

Common Name	Linear Feet / Transect #	200 / 1	200 / 2	200 / 3	180 / 4	200 / 5	340 / 6	Total 1320 / Average
		Cover Classes for Sections						
Cord Grass		3	2	-	2	2	-	2
Pickleweed		5	4	6	4	3	5	4
Salt Grass		2	3	2	2	2	2	2

Cover Classes: 1 = 0-5%
2 = 5-25%
3 = 25-50%
4 = 50-75%
5 = 75-95%
6 = 95-100%



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HEERDT MARSH

FIGURE
B1

Species List of Plants of Heerdt Marsh

Common Name	Scientific Name
Pickleweed	*Salicornia virginica* L.
Cord Grass	*Spartina foliosa* Trin.
Salt Grass	*Distichlis spicata* (L.) Greene
Gum Plant	*Grindelia humilis* H & A
Jaumea	*Jaumea carnosa* (Less.) Gray
Brass Buttons	*Cotula coronopifolia*
Alkali Heath	*Frankenia grandifolia* Cham. & Schlecht.
Slender Arrow Grass	*Triglochin concinna* Davy

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C. ENVIRONMENTAL IMPACT

(Section 15143)

HISTORICAL AND ARCHAEOLOGICAL SURVEY OF THE PROPOSED LARKSPUR FERRY TERMINAL LARKSPUR, CALIFORNIA

Elizabeth B. Goerke

May 1973

Submitted to:

Madrone Associates
35 Mitchell Blvd.
San Rafael, Calif.

Location and Description of Project

The proposed Larkspur Ferry site encompasses 25 acres bounded on the north by Sir Francis Drake Boulevard, on the south by a triangular pickleweed marsh, on the west by Wood Island, and on the east by a channel. This report will review the archaeological record and the more recent history of the general area and will make recommendations on mitigation of indirect impact on archaeological sites which will be affected by a widening of Sir Francis Drake Boulevard east of Highway 101.

Archaeological Background

The Marin County side of San Francisco Bay was occupied by an ethnographic group termed the Coast Miwok Indians of the Penutian language family (Kroeber 1925). They were a hunting and gathering people who resided in permanent villages along the Bay and on creeks that entered the Bay. Their staple food, which they learned to store, was the acorn. The Coast Miwok diet was supplemented by deer, elk and smaller animals, as well as fish, shellfish and vegetal foods such as clover, Brodiaea and miner's lettuce (Kelly 1932). This is well documented in the archaeological record and early ethnographic accounts. Today archaeologists are concerned with the nature of aboriginal social systems as well as the inhabitant's relation to his environment as seen in the settlement and subsistence systems (King 1970, AAM 1973).

The area east of Highway 101 to the Bay has three documented archaelogical sites. 4-Mrn-79 and 4-Mrn-80 were first recorded by Nels Nelson in 1907. 4-Mrn-80, located on the property just north of Hutchinson Company, was partially excavated in the 1950's by Aden Treganza. 4-Mrn-79, located north of San Quentin and between Sir Francis Drake Boulevard and Route 17, has not been excavated. It was partially destroyed when Sir Francis Drake Boulevard was altered in the 1950's. At that time Route 17 was widened in conjunction with Sir Francis Drake Boulevard, and an interchange with on- and off-ramps was constructed. In 1971 there were minor adjustments made to the road in that area. In 1955 Aden Treganza recorded 4-Mrn-255, describing it as "already levelled but could be excavated." He found Middle Horizon charmstones on the site. His report indicated that the site was on Remillard Brick Co. land under the brick kiln.

This area of the Bay has been proposed by some historians as a possible landing site for Sir Francis Drake. Any archaeological excavation in this area is essential for proving or disproving this theory (Treganza 1957, 1958).

Historical Background

Mr. Rex Silvernale of the Hutchinson Company and Mr. James Kidd, a local resident, supplied some historical background of the general area. When Mr. Kidd came to this area in 1910 the only sources of fresh water were a natural stream where Greenbrae School is now located and a spring behind the present Sanitary District land. The latter fed a natural pond which was later dammed to make a lake. Mr. Kidd sold water to residents who lived on Corte Madera Creek and also to visitors who arrived on weekends by train to picnic on the Remillard Brick property just north of the kiln. Clams were collected and opened on the edge of the small creek at the base of Wood Island. These clams were sold to residents and also transported to the city and sold in saloons, where they were in great demand. Mr. Kidd caught fish in the area and took his produce up the creek with the tide, trading it with a butcher in Larkspur and returning with the outgoing tide.

During prohibition, moonshine was fermented in the Remillard brick kiln, distilled in the house which now stands on the Hutchinson property (moved there from its original location at the weigh station) and sold to individuals who came for it in wagons. Some of the customers were guards from San Quentin. The label on the moonshine was "Coon Hollow."

The top of Wood Island has been bulldozed at least twice since 1912. A small shack owned by the Dean brothers gave it the name Deans' Island at the turn of the century.

The actual site for the proposed ferry terminal was marshland within the tidal zone of the Bay. Filling of this area was undertaken in 1924, when a channel was opened for the Hutchinson Quarry and the dredging soils were pumped onto the site. The major fills occurred in the late 1940's and late 1950's.

Surveying Plan and Results

Although the proposed site is on filled marshland, it is evident that such a major transportation facility would seriously impact adjacent areas.

The Phase I Master Plan report stated that Wood Island might become the locale of a motel. By its proximity to the terminal site it would become more attractive and accessible, and hence an archaeological reconnaissance of Wood Island was undertaken. It was determined from shell on top of the island (Macoma nasuta, Ostrea lurida and Clinocardium nuttallii) that a possible archaelogical site may have existed there prior to bulldozing. Material appeared to have been dumped, by bulldozing, on the top of a cut on the east side of the top of the island. More scattered shell was located on the west side, down the slope to the beach. In any case there is no site there today.

The Phase I report also stated that the City of Larkspur would widen Sir Francis Drake Boulevard east of Highway 101 to the City line near San Quentin. Mr. Hoffman of Hoffman & Albritton, civil and structural engineers, supplied the map for the proposed widening by the City of Larkspur. This four-lane highway would in essence extend the present right of way from the current 80' to 114.5'. The area was therefore walked on both sides of the highway to determine whether a widening would destroy or adversely affect an existing archaeological site. The road would come close to but apparently not destroy 4-Mrn-255 as described by Treganza. On further examination of this site, an obsidian projectile point was discovered in the soil just north of the kiln. Today, because of filling in the area and possible disruption during the construction of the sewage plant, it is difficult to describe 4-Mrn-255. There is always the possibility of subsurface finds which could possibly be uncovered during the preparation of the road.

The County design for widening Sir Francis Drake Boulevard from the Larkspur City line to the east 2,000' would extend the current right of way of approximately 26' to 40', except at San Quentin gate where the roadway would be 52'. This addition would be into the hill on the non-Bay side and would not adversely affect 4-Mrn-79 (personal communication, Mr. George Davison of the County Department of Public Works).

Recommendations

It is recommended that the Larkspur Ferry site be considered in relation to its indirect impact. Sir Francis Drake Boulevard must be widened to accommodate an increase in traffic. Recognition of the placement of archaeological sites is important to highway planners but not to the general public. There is always the danger of a publicized site being damaged by artifact hunters. If, in widening the highway, it appears that 4-Mrn-255 is in danger, the following steps should be taken to curb destruction:

1. Auger borings should be undertaken in the presence of an archaeologist to see whether there are any cultural remains buried at depth.

2. If archaeological features are discovered, then the site should be either covered protectively or salvaged by archaeologists and assistants.

3. Such an area should be protected by fencing or flagging in order that there be no incidental disturbance by bulldozers when they pull off the right of way to turn or park.

Summary

The proposed Larkspur Ferry site is on filled marshland, and therefore the limited area of the site is not affected historically or archaeologically. However, there is an element of indirect impact. Since a major communication service facility will attract further development, the surrounding area should also be considered. For this reason, an archaeological reconnaissance was made of Wood Island. Some shell fragments were discovered, but bulldozing operations have made it difficult to determine whether this had been a <u>bona fide</u> site.

With the widening of Sir Francis Drake Boulevard east of Highway 101 to the Bay there are further considerations. This highway was walked to determine the proximity of archaeological sites to the proposed extension. If, in widening the highway, it appears that 4-Mrn-255 is in danger, the following steps should be taken to curb destruction:

1. Auger borings should be undertaken in the presence of an archaeologist to see whether there are any cultural remains buried at depth.

2. If archaeological features are discovered, then the site should be either covered protectively or salvaged by archaeologists and assistants.

3. Such an area should be protected by fencing or flagging in order that there be no incidental disturbance by bulldozers when they pull off the right of way to turn or park.

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APPENDIX D - EXISTING WILDLIFE

TABLE OF CONTENTS

Appendixes to Appendix D

Appendix D

EXISTING WILDLIFE

EXISTING WILDLIFE

A. Introduction

The importance of the salt marshes and mud flats of San Francisco Bay to the Bay ecosystem has been well stated.[1,2] This importance becomes magnified when we realize that, as a result of diking and filling, only 25 percent of the salt marshes and mud flats that bordered San Francisco Bay one hundred years ago remain today.[1]

San Francisco Bay lies upon the Pacific flyway of migratory birds. It has been estimated that 70 percent of the shore birds using the San Francisco Bay mud flats during migration need these mud flats for their survival.[1] Shore birds feed upon invertebrates living in the intertidal mud flats. With the decrease of these mud flats over the last hundred years, the feeding grounds of our migratory shore birds have become depleted, thereby greatly increasing the importance of remaining mud flats.

Because of this critical situation, Madrone Associates has carried out a detailed analysis of the use of the mud flats by shore birds and invertebrate populations which would be affected by the development of the Larkspur Ferry Terminal site, in order to recommend appropriate and equitable mitigation measures with regard to wildlife needs should the site be developed.

Field studies have been conducted from October 1972 through June 1973, on marsh and mud flat vegetation, and on shore bird and invertebrate populations. (Sampling stations used for these

studies are given in Figure D-1.) Use of the area by fish and shellfish has been determined from existing data and from personal communication with fishermen and representatives of government agencies.

B. Vegetation on the Mud Flat Areas

Since it is known that mud flats contribute a significant proportion of the total primary food production of an estuarine-marsh system, studies were carried out in an attempt to evaluate the productivity loss caused by dredging 32.8 acres. Methods and data are found in Appendix D-1.

Statistical data on net oxygen production was not obtainable within the given time constraints; however, a number of observations were made which support the small amount of work on mud flat productivity published by other investigators.

1. The distribution of algae over the surface of the marsh was quite irregular but had relatively high density overall. (Chlorophyl a ranges from 2.46 mg/cu cm to 7.81 mg/cu cm on the pickleweed island). See Table 1, Appendix D-1.

2. There is considerable difference between species found in the barge channel and on the mud flat. The presence of *Euglena* and sulphur bacteria in the sewage outfall area is typical of their association with effluent and high organic loads. Several species of *Navicula*, a diatom common to both fresh and salt water habitats, comprised from 73 percent to 88 percent of the algae at the mud flat stations. Infrared photographs taken from the air revealed the high productivity of the marsh--particularly in a zone comprising Sampling Stations 6, 7 and 15.

3. The majority of species observed--diatoms, green and blue-green algae--are motile, an adaptation essential for the shifting sediments typical of a shallow bay such as Corte Madera Bay.

On the basis of natural plant associations, the site has been divided into four sections, as follows (see map, Figure D-2)

Section I. Marsh - 3.5 acres of the 7.5-acre area, under the jurisdiction of California State Lands Commission.

Section II. Island - approximately one acre formed by dredge spoils and located at the confluence of the barge channel and Corte Madera Creek.

Section III. Dike - 4.3 acres formed by dredge spoils and running parallel to the barge channel.

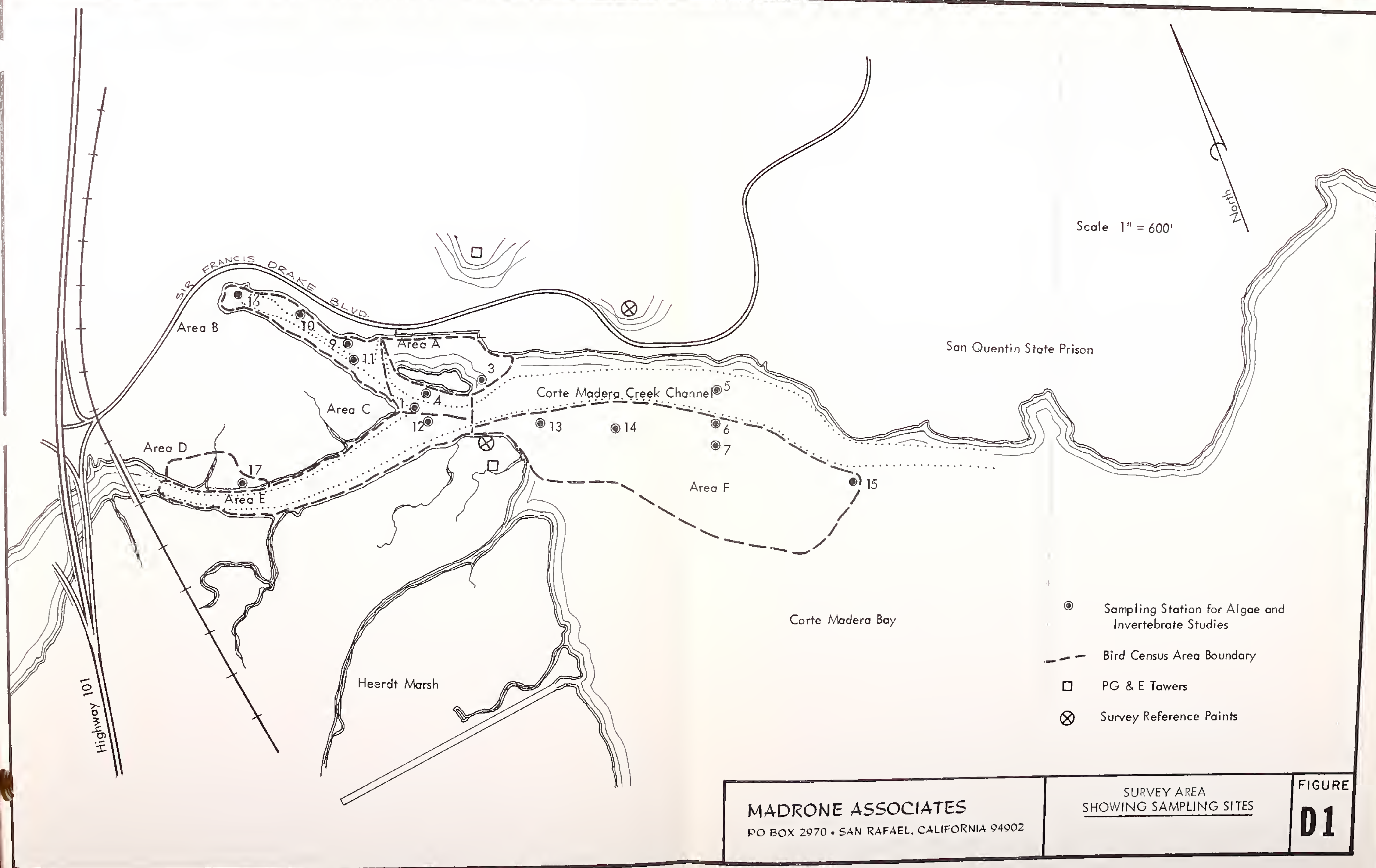
Section IV. Phase I parking lot site - 12.8 acres, the major portion of the site, already filled.

For details of materials and methods used in the vegetation analysis, see Appendix D-2.

Section I - Salt Marsh

The dominant plant in this salt marsh is the perennial pickleweed (*Salicornia virginica*), cover class* 5: 76 percent of the area sampled was dominated by this plant (see Table 2, Appendix D-2). The pickleweed carpets the entire marsh except for the deeper tidal meanders. (A meander is the entrenchment of a drainage pattern established over a mud flat by the draining of tidal waters. As silt is deposited, increasing the elevation of the mud flat, salt marsh plants become established. The drainage course then becomes fixed, changing only if it is blocked by a cave-in.) In these meanders, providing they are not deeper than 2.4 feet above

* Cover Classes: 1 = 0-5% cover; 2 = 5-25% cover; 3 = 25-50% cover; 4 = 50-75% cover; 5 = 75-95% cover; 6 = 95-100% cover.



Scale 1" = 600'
North
SIR FRANCIS DRAKE BLVD.
San Quentin State Prison
Area A
Area B
Area C
Area D
Area E
Area F
Corte Madera Creek Channel
Corte Madera Bay
Heerdt Marsh
Highway 101
1
3
4
5
6
7
9
10
11
12
13
14
15
16
17
Sampling Station for Algae and Invertebrate Studies
Bird Census Area Boundary
PG & E Towers
Survey Reference Paints
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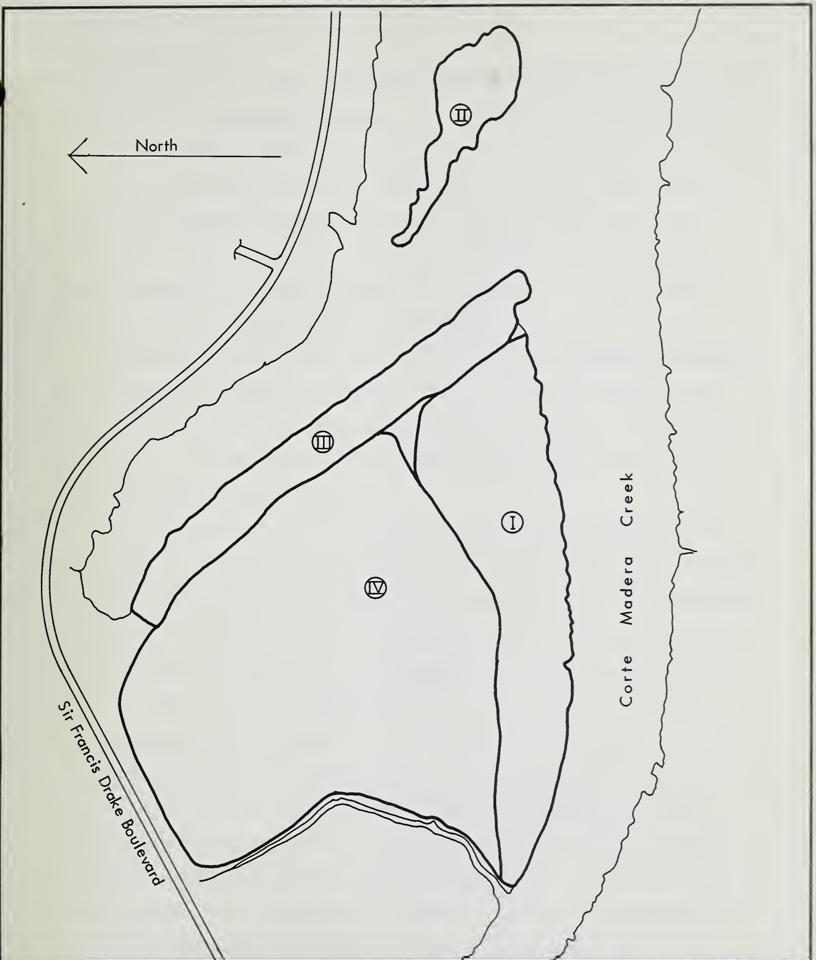
SURVEY AREA
SHOWING SAMPLING SITES
FIGURE
D1



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VEGETATIVE ANALYSIS SECTIONS

FIGURE D2

Mean Sea Level (5.4 feet above Mean Lower Low Water) occur colonies of cord grass (*Spartina foliosa*). Cord grass is in cover class 2 (5 to 15 percent) in the transect area.

The third plant found in significant numbers is salt grass (*Distichlis spicata*) another perennial grass. The colonies of salt grass form turf at the higher elevations and mixed stands with pickleweed in lower places. Salt grass is in cover class 1, covering three percent of the area sampled.

The other plants falling in cover class 1 are *Atriplex Jaumea*, marsh rosemary, *Grindelia*, brass buttons and yellow sweet clover. These are all typical of San Francisco Bay salt marshes, with the exception of yellow sweet clover, which grows on the edge.

Section II - The Island

The island has an area of approximately 33,000 square feet (0.75 acre). Here the pickleweed cover is especially dense. Plants found on the island and corresponding cover classes are as follows: pickleweed (6); cord grass (2); *Grindelia* (2); dodder, a parasite on pickleweed and *Atriplex* (2); *Atriplex* (1); brass buttons (1); and the green alga *Enteromorpha* (1).

Section III - The Dike

Any high area of bay mud such as a dike or pile of dredging spoils near or in a salt marsh will support a mixed plant community. This dike is typical, with salt marsh and upland species of plants. These (and their cover classes) are: pickleweed (3), annual grasses (3), *Atriplex* (2), coyote bush (2), *Grindelia* (1), cord grass, mustard, salt grass, thistle, wild anise, and wild

radish (all in class 1). Plants present in smaller numbers are brass buttons, salt marsh bulrush, dodder, bristley ox tongue, Bellardia, plantain, scarlet pimpernel, yellow sweet clover, Senecio, Acacia, and one plant of slender arrow grass (Triglochin maritima).

Section IV - The Parking Area

The plant cover on the parking area is more sparse, even though the variety of species is greater. The substrate is gravelly fill, well compacted, with very little topsoil or humus developed. The majority of the plants present here are generally described as weedy species.

Annual grasses (cover class 3), pickleweed (2), plantain (2), and redstem filaree (2) are the most numerous. Cord grass, brass buttons, wild anise, yellow sweet clover, dandelion, Jaumea, Grindelia, owl's clover and bristly ox tongue are the next most common, although all are in cover class 1. Plants having cover of less than one percent are marsh rosemary, Atriplex, pampas grass, Bellardia, scarlet pimpernel, vetch, broom, burclover, lupine, white sweet clover, wild geranium, tarweed, blue-eyed grass and toyon.

C. A Study of the Invertebrate Population in the Larkspur Ferry Terminal Project Area

The mud flats of San Francisco Bay provide a habitat for many species of invertebrates which serve as food for the birds and fish using San Francisco Bay. Mud flat invertebrates such as worms, clams, and small crustacea feed on plankton and decomposing organic

material produced mainly by the marsh vegetation and mud flat algae.

The San Quentin mud flat is rich in invertebrate numbers and species diversity. In a study conducted from December to June, over 45 species were collected. The study site varies significantly from area to area and station to station. For methods and data, see Appendix D-3.

In March, sampling stations were changed to better correlate with observed bird feeding patterns, so that direct correlations between December and March figures are not possible. The total number of invertebrates collected in December was greater than those collected in March in spite of fewer stations. There were six times as many invertebrates in June as in March, an increase which was significant for all groups except polychaetes, which showed June levels similar to those of March.

Crustaceans, consisting almost entirely of amphipods, increased enormously from March to June. Amphipods were so abundant in June samples that only the small-sized samples were counted.

Polychaetes made no apparent changes from March to June. Streblospio benedicti appears to be only invertebrate species in the area that dropped in numbers from March to June.

Oligochaetes increased significantly from March to June. The larger numbers of December compared with those of March may be a result of different station locations.

Mollusc totals decreased from December to March and then increased from March to June. Gemma gemma decreased from December

to March. Mya arenaria and M. balthica increased in numbers from December to March and then made huge increases from March to June. Gemma gemma also increased significantly from March to June. Evidence gathered indicates that these population changes are probably due to migration, most likely caused by seasonal changes in salinity and temperature.

Because of these findings regarding the vertical migration of clams, the current practice of using grab samplers in benthic studies throughout the Bay area may be rendered invalid.

Large shells of Macoma nasuta were found in abundance throughout the study area but not one live specimen was found. This clam is common and abundant elsewhere in San Francisco and San Pablo Bays but appears to have died out in this area.

To describe the invertebrate species distributions in valid statistical terms, invertebrate species collected in March and June were subjected to a one-way analysis of variance. Those with a significant difference were subjected to a multiple range analysis. The increased significant differences found in June may be a result of the total increased number of invertebrates found. The increased numbers of significant differences found in March for Streblospio benedicti may also be a result of larger total numbers found in March over June.

For a full explanation of migration see Appendix D-3.

Description of Areas

Stations 9, 10, 11 and 16 were in bird census area B. Stations 9 and 10 were nearly devoid of invertebrate life in March and June.

Station 16 had significantly more oligochaetes than at any other station. Oligochaetes are well known pollution indicators[3] Station 11, which is never exposed by low tides was nearly devoid of life in March. This was probably a result of the increased amounts of untreated winter sewage from the nearby sewage outfall. Many species appeared at this station in June. One species, Capitella capitata is a pollution indicator.[4,5] Bubbles of sulfurous gases constantly percolated up from the mud of area B and the black anaerobic layer was much nearer the surface than in any other area examined. Area B appeared to be highly polluted. A large and diverse fauna existed in all areas outside of area B.

The deep stations 5 and 12 in the middle of the channel were significantly different from each other and from all other stations examined. At station 12, Gemma gemma and Streblospio benedicti were the dominant species. At station 5, Gemma gemma was abundant but significantly less so than at station 12. Ampelisca milleri, Corophium acherusicum, Corophium spinicorne and Mya arenaria were in significantly larger numbers at station 5 than at any other station. All of the major species of invertebrates found in the deep stations also were found on the mud flats but their relative numbers were almost all significantly less on the mud flats.

Area F was the largest area and more samples were collected from it than any other area. The largest amount of diversity was also found within this area. The polychaete worms Nerine cirratulus, Nerinides sp. and Pygospio elegans were found only in Area F. Both specimens of an undescribed species of amphipod in

the genus *Melita* were found there. A hybrid between *Corophium spinicorne* and *Corophium insidiosum* was found at station 14. This is the only location known for this hybrid. In this paper it is listed as "*Corophium* sp."

In 1949, a new species called *Corophium oaklandense* was described from a single specimen found in Lake Merritt, Oakland. Some of the hybrid forms of "*Corophium* sp." found in this study match the description of *C. oaklandense* and will probably render *C. oaklandense* invalid as a species.

Conclusion

Dredging a channel will do more to change the distributions and abundances of the local invertebrates than to eliminate them. The significance of these changes is unknown.

Amphipods are a primary source of food for birds and fish throughout the world. The hybrid amphipod (*Corophium* sp.) found and tentatively identified in this study is of evolutionary, morphologic and taxonomic significance because crosses between *Corophium* species have not previously described. Their loss from dredging operations will make further research unlikely because at the present time Station 14 is the only known location for this amphipod.

A new species of amphipod in the genus *Melita* was also found in areas to be dredged. Its distribution, much less its importance, cannot be determined as it is not recorded in the literature.

Fish that depend on the mud flats for invertebrates not abundant in the channels will have their food supply reduced by the dredging operation.

Dredging the barge channel (Area B) will increase the flushing activity and improve the water quality. This could be beneficial to fish and invertebrates of the area.

D. Fish in Corte Madera Creek

The fish of San Francisco Bay are an important food source for humans and provide many hours of recreation. Their economic value resides chiefly in their use by commercial fisheries, and indirectly in associated services such as the manufacture and sale of sport fishing equipment. Ecologically, fish are vital in the food chain of other Bay organisms, such as larger fish, birds and marine animals.

The mouth of Corte Madera Creek, the site of the ferry terminal, has been rated high in relative value as a habitat for fish and other wildlife.[(2)] This priority has been assigned because steelhead trout migrate through this region to spawn. In addition, the mud flats and marshes surrounding this channel provide the food, shelter, and oxygenation necessary for the survival of juvenile fish and the organisms which serve as food for fish.

Information about the fish using Corte Madera Creek and its estuary has been accumulated from the following sources:

> From 1959 to 1964, a study of the fish in Corte Madera Creek from Greenbrae to Ross was conducted by Mackey and Kirschbaum,(6) in which they identified 17 species of estuarine fishes and 7 species of fresh water fishes. Their list is found in Appendix D-4.
>
> The U. S. Army Corps of Engineers conducted an electroshocking survey of the fish in Corte Madera Creek on November 26, 1969. The report showed a run of 300 to 500 adult steelhead trout between December and March. A total of 31,046 yearling steelhead trout were counted

in Corte Madera Creek and its tributaries during this study; and year-round residents of the creek such as sticklebacks, roach and mosquitofish were also recorded.[7]

As part of a study of available fishing sites around San Francisco Bay conducted for the California Department of Fish and Game, T. W. Wooster included a shoreline site located just west of San Quentin Prison beside Sir Francis Drake Boulevard. The principal fish caught during 2000 angler-days per year were striped bass and large perch.[8]

Roger Green and Mickey Eldredge of the National Marine Fisheries Service in Tiburon conducted a survey on January 17, 1973, in the mouth of Corte Madera Creek opposite the prison. Their findings parallel Dr. Mackey's list of species found further up the creek toward Ross.

A Madrone Associates census of people fishing along Sir Francis Drake Boulevard near San Quentin, the Greenbrae boardwalk, and Bon Air Bridge found that 10 species of fish are most often caught. These species and the times they are usually caught is listed in Appendix D-4.

By combining the lists just discussed, we find that at least 29 species of fish use Corte Madera Creek, its estuary and its tributaries as habitat during all or some part of their life cycle.

E. The San Quentin Shellfish Bed

In 1967, Ted Wooster from the California Department of Fish and Game walked the entire shoreline of San Francisco Bay in order to identify shellfish beds and to sample clams, mussels and oysters in these beds. In Marin County, beds were identified in the Gallinas Creek area, in the Rat Rock area, along Corte Madera Creek just west of the prison on the San Quentin Peninsula, at Strawberry Point and in Richardson Bay.[9] The San Quentin bed is relatively small, 9600 square feet in area, with an estimated total of 201,600 soft-shell clams (*Mya arenaria*). No Japanese littleneck clams

(*Tapes semidecussata*) or native oysters (*Ostrea lurida*) were found in this bed.

The soft-shelled clam was abundant and widely distributed in San Francisco and San Pablo Bays in the late 1800's and had considerable commercial importance. In 1916, 540,000 pounds were sold, but by 1927, the take was down to 150,000 pounds.[9] At present, there is no commercial harvest; in fact, the Marin County Health Department has posted signs stating that shellfish in this area are unfit for human consumption.

Marin Sanitary District No. 1 discharges effluent into Corte Madera Creek just opposite the projected Larkspur Ferry Terminal site, 800 feet west of shellfish bed No. 40.[10] San Quentin Prison discharges effluent into Corte Madera Bay where the boat channel from Corte Madera Creek passes the prison approximately 1500 feet east of shellfish bed No. 40. Samples taken on July 28 and 29, 1969, had fecal coliform organism densities of 33,000 and 2,800 per 100 grams of meat, respectively.[10] Acceptable density is 230 fecal coliform organisms or less per 100 grams of meat. Thus, before this bed could provide clams fit for human consumption, it would be necessary to relocate or eliminate the sewage outfalls; however, it must be noted that houseboats, arks, small boats and faulty septic systems also contribute to the poor sanitary quality of Corte Madera Creek.

Should the sewage outfalls be relocated, the San Quentin shellfish bed would become a valuable resource because of its excellent public access. There is roadside parking available, and many fishermen presently make year-round use of this beach.

In a 1972 survey of shellfish in the beds identified in the 1967 study, the mean sizes and weights of the soft-shelled clam (*Mya arenaria*) were similar to the original data. Numbers of "angler-days" were computed from the number of clams 38 mm or larger estimated from the sample data and the bed size. The San Quentin bed yielded 100 "angler-days" using 1972 data.(11) Though these clams cannot be utilized at present, the economic value of the bed has been estimated by Milton Tunzi, biologist for the Environmental Protection Agency, at $1.50 to $15.00 per angler-day.(11)

F. Shore Bird Population Study

There are few publications about shore bird feeding habits and fewer concerning local shore bird populations. Bird censuses were taken, and invertebrate samples and sediment samples were collected to study their distribution, abundance and relationships in the different areas of the San Quentin mud flat.

A census of the bird population was begun October 22, 1972, and continued through June 7, 1973.

Censuses were taken on the falling phase of the tide in six areas, A through F, as shown on the map in Figure D-1. These areas were selected because they were distinguishable from each other geographically and because each area could be readily observed by the census takers. Table D-1, following this page, describes the location, the substrate composition, the species most frequently found, the invertebrate sampling station, and the invertebrates found there in significant abundance for each area.

Table D-1. Summary Table of Birds, Substrate and Invertebrates Found On Site

BIRD CENSUS AREA	LOCATION	BIRDS MOST OFTEN SEEN	SUBSTRATE	INVERTEBRATE SAMPLING STATIONS	PREDOMINANT INVERTEBRATES IN MUD
A	Island-North: Mud flats north of small pickleweed island	Dunlins Westerns Avocets Marbled Godwits	Black, sulfurous mud of fine silt and organic matter; very soft	SQ-3	Peloscolex sp. - 3* (oligochaete worm) Streblospio benedicti (polychaete worm)
B	North-Channel: old barge channel north of site and west of island	Dunlins Westerns Avocets Coots		SQ-9 SQ-10 SQ-11 SQ-16	Oligochaete worms - 16*
C	Island-South: mud flats south of small pickleweed island	Dunlins Westerns Avocets Coots Gulls Marbled Godwits	Mud: brown at surface, black 1 cm. below surface; slightly firmer than Area A	SQ-4	Streblospio benedicti - 4* (polychaete worm)
D	Pond and Ditch: small depressed area on the southern edge of site; flooded in winter; ditch next to woods 15	Avocets Killdeer			
E	Corte Madera Creek and shores	Ducks: canvasback, ruddy, mallard and scaup	Up to 98% silt	SQ -12	Gemma gemma (small clam) Streblospio benedicti (polychaete worm)
F	San Quentin mud flat and channel; extends from tip of site and island to end of reasonable visibility	Willets Dunlins Westerns Coots Gulls	Coarse gravel, small amounts sand and silt; soft brown mud with small amounts of gravel and sand; firm mud and sand	SQ-5 SQ-6 SQ-7&8 SQ-13 SQ-14 SQ-15	Grandidierella - 5* japonica (amphipod) Gemma gemma - 7 & 8* (tiny clam)

* Most abundant at this station

A complete tabulation of the bird census data is located in Appendix D-5.

The data show that 20 species of marsh and shore birds use the mud flats and 19 species of water-associated birds (ducks, grebes, gulls, terns, cormorants, and coots) use the area.

Fall migration of shore birds through the area was spread over a period of several months. Spring migration brought greater concentrations of birds over a shorter period. Spring migration was restricted mainly to March and April with peak migration in April. This is in agreement with findings of Recher, 1966; Smail, 1969; Gill, 1972; Page, 1973.[12,13,14,15]

Shore bird feeding began in high intertidal areas (A and C) and expanded to other areas as they were uncovered by the receding tide. Birds returned to Areas A and C as the tide returned. In March and April, feeding continued as long as any of the mud flat was exposed.

The larger species of shore birds (marbled godwits, whimbrels, long-billed curlews) were more selective than the smaller shore birds and fed primarily on the large invertebrates deep in the mud, such as the clams Macoma balthica and Mya arenaria. The smaller shore birds and avocets fed primarily on surface organisms such as annelids, crustaceans and possibly the small clam Gemma gemma. This observation conforms with those of Recher.[12]

Recher[12] emphasizes the idea that available space may be a more important environmental factor than available food in limiting

migrant shore bird populations. This may be entirely true for the western sandpiper and the least sandpiper found together in this study. They have overlapping niches with the slightly larger, more aggressive western sandpiper excluding the smaller least sandpiper from many feeding sites. A reduction in the size of the mud flat may increase the competition between the least and western sandpipers.

The study has shown an intimate relationship between available food and the presence of a wintering shore bird population. Marbled godwits showed a significant preference for Areas A and C. Avocets showed a significant preference for Area B. The marbled godwits could have been feeding on the very abundant Macoma balthica or on the variety of invertebrates found in the mud banks of Areas A and C. The avocets could only have been feeding on oligochaetes which were nearly the sole inhabitants of the area and in greater abundance than anywhere else. Both marbled godwits and avocets will lose favored feeding grounds as a result of dredging.

Invertebrates are the primary food source for shore birds. Polychaetes and amphipods have short life spans and generally undergo large population fluctuations which are dependent on weather conditions such as temperature and salinity. Thus, the shore bird food supply tends to be somewhat unreliable. Extensive dredging of the mud flat will reduce this food supply for all shore birds using the area.

G. Rare and Endangered Species

In a publication of the Department of Fish and Game on rare and endangered species, Howard Leach includes a quote by Joshua Lederberg, world-renowned geneticist.

> The variety of species is a great library of information, literally encoded in the specific DNA molecules that characterize each type. It is paradoxical that, in this era of most rapid elimination of natural variety, we have begun to learn the keys to that code and to appreciate the subtleties of the evolutionary mechanism that it drives. Each different species is a unique adaptation to its own way of life, a lesson in "how to live" that we never properly understand after we extinghish it.(16)

Salt Marsh Harvest Mouse

Because of the vast reduction of salt marsh around San Francisco Bay due to extensive diking and landfill measures, the salt marsh harvest mouse (*Reithrodontomys raviventris*) has been placed on both State and Federal endangered species lists.

The salt marsh harvest mouse has been differentiated into two subspecies, R. r. *halicoetes*, found in the northern and eastern regions of the Bay, and R. r. *raviventris*, found in the central and south Bay. The ability of this species to sustain itself on a salt-water drinking supply is shared with only a few desert species of small mammals.[17] The physiological and evolutionary value of this animal is therefore of extreme importance.

In a salt marsh harvest mouse survey conducted by the State of California's Department of Fish and Game in 1971,[18] a very small population of R. r. *raviventris* was found in the Heerdt marsh, across Corte Madera Creek from the project site.

On May 24 and again on May 31, 1973, Messrs. Gil Thompson and Cal Hampy from the Department of Fish and Game trapped for the harvest mouse in the State Lands marsh adjacent to the project site. Neither trapping produced any harvest mice. This, of course, does not mean they do not exist in this marsh, which has good pickleweed habitat for the harvest mouse; nevertheless, it cannot be stated emphatically that they are there.

California Clapper Rail

The California clapper rail (*Rallus longirostris*) also has become an endangered species because of the restriction of salt marsh habitat and because the rail is apparently incapable of adapting to environmental change.[16] The clapper rail builds a nest of dead grasses and marsh plants on clumps of new cord grass growth.[19]

On May 24, 1973, a California clapper rail was sighted by Madrone Associates staff and Messrs. Gil Thompson and Cal Hampy of the Department of Fish and Game on the State Lands marsh, adjacent to the ferry terminal site. A freshly constructed nest was also seen.

California clapper rails have also been sighted by members of the Marin Audubon Society in the Heerdt Marsh. These sightings have been documented since 1967.[20]

There are no rare or endangered species on the Larkspur Ferry Terminal site itself, which has been filled several times since 1924. A sparrow hawk (*Falco sparverius*) has been seen hunting over the site on occasion; however, the site at present is not considered

to be rich habitat for raptors. The area is unsuitable for the colonization of mice because of considerable amounts of dumped asphalt covering the surface and soil compaction by heavy trucks.

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Appendix D-1

ALGAE STUDIES: POTENTIAL PRODUCTIVITY AND LEVELS OF ALGAE FOUND ON THE MUD FLAT

DETERMINATION OF THE CHLOROPHYLL a CONTENT

IN POTENTIAL PRODUCTIVITY STUDY

Three om^3 cores of sediment were collected from each location on June 6, 1973 (Figure 1) and each core placed into a glass vial. Immediately upon returning to the laboratory 5ml of 90 percent acetone in distilled water was added to each vial. The vials were capped, agitated to break up the sediment cores, and placed in a refrigerator at 5 degrees C for 18 to 20 hours. During this period the pigments were extracted from the chloroplasts by the acetone. The acetone extract was decanted into 10ml centrifuge tubes and centrifuged at high speed in the clinical centrifuge to rid the extract of suspended sediment. The clear green supernatant was decanted into a 1 cm light path quantz cuvette fitted with a ground glass stopper. Readings were taken at 630 nm, 645nm, and 665nm using a Beckman DB-G Grating Spectrophotometer. The tungston filament light source was used at these three wave lengths and the reference cuvette was filled with 90 percent acetone. The chlorophyll a content was calculated by using the following equation (SCOR-UNESCO, 1966):

$$\text{Chl } \underline{a} \text{ ug/cm}^3 \text{ Sediment} = 11.64 \text{ O.D.}_{663} - 2.16 \text{ O.D.}_{645} - .10 \text{ O.D.}_{630}$$

where O.D. is the optical density at the various wave lengths.

CHLOROPHYLL a ANALYSIS AS A

RELATIVE INDICATION OF PHOTOSYNTHESIS

Location	mg/cm^3 Sediment
1	5.00
3	3.94
4	7.81
6	2.46
11	2.56
13	4.23
14	4.17
15	3.01

Table 1 - Levels of Algae Found in Selected Sampling Stations in Project Area

Species	Sampling Station * (%)								
	1	3	4	6	11	13	14	15	18
Achnanthes	20	3	3	-	2	<1	1	1	<1
Amphora	-	-	-	-	-	-	-	2	<1
Bacillaria paxillifer	-	<1	-	-	-	-	-	-	-
Caloneis westii	-	-	-	-	2	-	-	-	-
Cocconeis	<1	<1	-	-	8	-	1	-	-
Coscinodiscus	-	<1	3	p	-	-	<1	-	p
Cymbella	<1	<1	-	-	-	<1	-	1	-
Euglena	-	-	50	-	11	-	-	-	<1
Flagellate	p	-	-	-	-	-	-	-	-
Grammatophora	-	-	3	-	-	-	-	-	-
Gyrosigma fasciola	4	6	p	<1	26	7	1	-	16
Hantzschia amphioxus	-	<1	-	-	-	-	-	-	-
Melosira moniliformis	-	-	p	-	-	-	-	-	-
Microcoleus lyngbaceus	-	-	3	<1	p	p	-	-	-
Navicula +	59	81	38	77	44	88	81	88	73
Nitzschia	<1	6	p	-	-	<1	-	-	5
Nitzschia apiculata	-	<1	-	-	-	-	-	-	-
Nitzschia longissima	-	-	-	9	-	-	8	-	-
Pinnularia	3	<1	-	-	-	<1	-	4	-
Pleurosigma	-	-	-	3	-	-	3	2	-
Pleurosigma decorum	7	<1	p	5	2	<3	1	1	p
Schizothrix	p	-	-	3	-	<1	-	-	2
Spirulina subsalsa	-	-	-	<1	-	-	<1	-	-
Synedra fasiculata	2	<1	-	-	-	-	-	-	-

* Percentages represent averages of ten microscopic fields selected at random

+ Approximately 10 different species

p = present in quantities too small to be counted

Identifications by:

Kjeldsen, Chris W. 1973. Chairman, Department of Biology, California State College, Sonoma. Personal communication, and identification of mudflat algae.

Appendix D-2

MATERIALS AND METHODS
FOR VEGETATIVE ANALYSIS OF THE
LARKSPUR FERRY TERMINAL SITE

MATERIALS AND METHODS FOR VEGETATIVE ANALYSIS OF THE LARKSPUR FERRY TERMINAL SITE

The sampling methods were patterned after those of Daubenmire (1968) and Oosting (1956).*

In the marsh (Section I) a baseline was established between a point on Wood's Island and a point on the San Quentin peninsula bisecting the marsh lengthwise. Transects were measured off at 100-foot intervals from shore to the inland marsh edge perpendicular to the baseline. This allowed observation of any existing zonation. The transect is a belt three feet wide and the number of feet of this belt that are covered or dominated by a species is recorded. In a forest, it is possible to have 300% coverage of the ground, e.g., trees, shrubs, and ground cover may each cover the ground 100%. This percentage is recorded as a cover class number; 0-5%=Class 1, 5-25%=Class 2, 25-50%=Class 3, 50-75%=Class 4, 75-95%=Class 5, and 95-100%=Class 6. For arithmetic calculations, the median number of the cover class is used. Ten transects totaling 1417 linear feet were analyzed.

On the island (Section II) because of the small size and homogeniety, cover classes were assigned by eye after the measurements were made.

The dike (Section III) was sampled by means of 100-foot transects taken every 100 feet and placed approximately at right angles to the barge channel. Fourteen transects totaling 1300 linear feet were analyzed.

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The proposed parking site (Section IV) was measured by means of 10-foot-square quadrats. A baseline was established and perpendicular lines were measured every 200 feet in both directions. Along these lines the quadrat points were established at intervals of 200 feet. Fifteen quadrats totaling 1500 square feet were analyzed.

Common Name	Scientific Name	Cover Class Number* for Sections			
		I	II	III	IV
Salt Grass	Distichlis spicata (L.) Greene var stolonifera Beetle	1	-	1	1
Pickleweed	Salicornia virginica L	5	4	3	2
Atriplex	Atriplex patula L. ssp. hastata (L.) Hall & Clem.	1	1	2	1
Cord Grass	Spartina foliosa Trin.	2	2	1	-
Sea Lavender, Marsh Rosemary	Limonium californicum (Boiss.) Heller	1	-	-	1
Jaumea	Jaumea carnosa (Less.) Gray	1	-	-	1
Grindelia, Gum Plant	Grindelia humilis H. & A.	1	2	1	1
Marsh Dodder	Cuscuta salina Engelm.	-	2	1	-
Brass Buttons	Cotula coronopifolia L.	1	1	1	1
Coyote Bush	Baccharis pulularis D. C.	-	-	2	-
Summer Mustard	Brassica geniculata (Desf.) J. Ball	-	-	1	-
Thistle	Cirsium edule Nutt.	-	-	1	-
Wild Anise (Sweet Fennel)	Foeniculum vulgare Mill.	-	-	1	1
Wild Radish	Raphanus sativus L.	-	-	1	-
Salt Marsh Bulrush	Scirpus robustus Pursh.	-	-	1	-
Bristly Ox Tongue	Picris echioides L.	-	-	1	1
Bellardia	Bellardia Trixado (L.) All.	-	-	1	1
Plantain, English	Plantago lanceolata L.	-	-	1	2
Scarlet Pimpernel	Anagallis arvensis L.	-	-	1	1
Yellow Sweet Clover	Melilotus indicus (L.) All.	-	-	1	1

* Cover Classes: 1 = 0% to 5% cover; 2 = 5% to 25% cover; 3 = 25% to 50% cover; 4 = 50% to 75% cover; 5 = 75% to 95% cover; 6 = 95% to 100% cover.

Common Name	Scientific Name	Cover Class Number* for Sections			
		I	II	III	IV
White Sweet Clover	Melilotus albus Desr.	-	-	-	1
Senecio (Groundsel, Ragwort)	Senecio L.	-	-	1	-
Blackwood Acacia	Acacia melanoxylon R. Br.	-	-	1	-
Slender Arrow Grass	Triglochin maritima L.	-	-	1	-
Redstem Filaree	Erodium cicutarium L'Her.	-	-	-	2
Dandelion	Taraxacum officinale Wiggers	-	-	-	1
Owl's Clover	Orthocarpus densiflorus Benth.	-	-	-	1
Vetch	Vicia sp.	-	-	-	1
Broom		-	-	-	1
Burclover	Medicago hispida Gaertn.	-	-	-	1
Lupine, white	Lupinus sp.	-	-	-	1
Wild Geranium	Geranium sp.	-	-	-	1
Tarweed	Hemizonia sp.	-	-	-	1
Blue-eyed Grass	Sisyrinchium bellum Wats.	-	-	-	1
Toyon	Heteromeles arbutifolia M. Roem.	-	-	-	1
Annual Grasses	Gramineae	-	-	3	3
Pampas Grass	Cortederia Selloana (Schult) Asch. & Graebn.	-	-	-	1
Enteromorpha	Enteromorpha sp.	-	1	-	-

*Cover Classes: 1 = 0% to 5% cover; 2 = 5% to 25% cover; 3 = 25% to 50% cover; 4 = 50% to 75% cover; 5 = 75% to 95% cover; 6 = 95% to 100% cover.

References for Plant Identification

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Appendix D-3

MATERIALS AND METHODS FOR
INVERTEBRATE STUDY
OF LARKSPUR FERRY TERMINAL SITE

MATERIALS AND METHODS FOR
INVERTEBRATE STUDY
OF LARKSPUR FERRY TERMINAL SITE

On December 22, 1972 invertebrate sampling stations were established for a presurvey. Their locations were determined with a surveyor's transit from a known location overlooking the mud flat areas. Core samples of benthic invertebrates were collected at each station. Two core sizes were used as follows:

1. For the larger and less numerous invertebrates with a four-inch diameter core was inserted into the substratum to a minimum depth of six inches and a maximum depth of one foot. Samples were washed through a 1.18 mm mesh screen.

2. For the smaller invertebrates, a 2.5-inch diameter core was inserted to a minimum depth of three inches and a maximum depth of 3.5 inches. Samples were washed through a 0.42 mm mesh screen.

All specimens remaining in the screens were bottled and preserved for later sorting and identification.

In the December presurvey, three large samples and three small samples were taken at each sample station. The large samples consisted of two four-inch-diameter cores combined. The small cores consisted of three 2.5-inch-diameter cores. In March and June, samplings at each station were increased to four large and four small samples of the same sizes as in December.

Six sampling stations were established in December. In March, the December Station SQ8 was abandoned, Station SQ3 was moved slightly, and Stations SQ9 through SQ17 were added, all to better correlate with observed bird feeding patterns. A four-foot-square area was caged off at Stations SQ3, SQ4, SQ13, SQ14 and SQ15 to determine the amount of predation upon the invertebrates by birds and fish. These

additional stations were called "K Stations." In June, samples were collected from inside the caged area and from without where the birds could feed.

Transit readings using magnetic north were taken for each station from two locations (see Figure D-1 in Appendix D). Location A is a small knoll overlooking the entire site. A marker was placed at the edge of a terraced portion near the top. Location B is on the south side of Corte Madera Creek and 200 feet north of the PG&E electrical tower, and directly under the power lines. A marker was placed at this location also. The transit compass lined up with the power lines and offset all readings by 58^{o} 25'; that amount was subtracted from all headings recorded under the power lines. Headings for all stations from Locations A and B will be called Headings A and B, respectively.

For the silt analysis, sediment samples were collected at each station. A preweighed amount of each sample was dried and reweighed to determine the percentage of water. A second amount from each sample was weighed and then washed through a 0.62 mm mesh screen. That amount remaining in the sieve after washing was washed onto preweighed Whatman No. 40 filter paper, dried and reweighed. The weight of the paper was subtracted from the total weight to determine the weight of sand sized particles. Percent sand was then calculated and from that, percent silt was determined.

Station Locations and Descriptions

Station SQ1: Located at the end of the point of land separating the "North Channel" from Corte Madera Creek. Headings (a) 294° 40' and (b) 253° 37'. 60% silt.

Station SQ3: Originally located about 20 feet from center of "Pickle Weed Island"; mud black and sulfurous, composed of 59.83% silt. This station was moved slightly to the eastern end of the island in March where Marbled God-wits were more common. The headings were (a) 294°40'; and (b) 253° 07' from the new location.

Station SQ4: Located one hundred feet south from the center of "Pickle Weed Island." Headings (a) 274° 55' and (b) 279° 38'. 90% silt.

Station SQ5: Located directly north of Station SQ6, directly south of outer cyclone fence surrounding San Quentin State Prison and in the center of Corte Madera Creek Channel. Depth 10 feet; about 25% silt. No headings.

Station SQ6: Located at channel edge south of outer cyclone fence surrounding San Quentin State Prison. Headings (a) 157° 26' (b) 41° 4'. 97% silt.

Station SQ7: Located 150 feet from channel edge directly in line with Stations SQ5 and SQ6. Headings (a) 162° 57' and (b) 43° 48'. 66% silt.

Station SQ8: Located 200 feet east of Heerdt March and 450 feet east of the main channel; 53% silt; station was abandoned so headings were not taken.

Station SQ9: Located 150 feet east of the sewage outfall and 50 feet south of the dirt bank. Headings (a) 238° 44' and (b) 267° 53'. 94% silt.

Station SQ10: Located halfway between Stations SQ16 and SQ11 and 50 feet south of the dirt bank. Headings (a) 287° 47' and (b) 268° 42'. 97% silt.

Station SQ11: Located directly in the center of the "North Channel" and 100 feet west of the sewage outfall channel. Headings (a) 281° 18' and (b) 263° 56'. 97% silt.

Station SQ12: Located in the center of the Corte Madera Creek Channel and directly southwest of the point of land dividing Corte Madera Creek from the "North Channel." Depth to eight feet; headings not given; silt 98%.

Station SQ13: Located 200 feet east of Heerdt Marsh and 100 feet from the channel edge. Headings (a) 257o 45' and (b) 4° 48'; 68% silt.

Station SQ14: Located halfway between Stations SQ7 and SQ13, 100 feet from the channel edge. Headings (a) 230° 25' and (b) 33° 27'; 26% silt.

Station SQ15: Located approximately 3/8 of a mile southeast of Heerdt Marsh and 100 feet from the channel. Headings (a) 145° 48' and (b) 53o 38'; 65% silt.

Station SQ16: Located at the far end of the "North Channel." Headings (a) 270° 15' and (b) 262° 40'; 98% silt.

Air temperature and cloud cover throughout the course of the study are given in Table 1. Water temperature in March averaged 12.5°C and the average chlorinity, 13.4 0/00. Average water temperature of June was 7°C and the chlorinity 21.2 0/00.

BENTHIC INVERTEBRATE FAUNA, SAN QUENTIN MUD FLAT
CORTE MADERA BAY, MARIN COUNTY, CALIFORNIA
DECEMBER 1972, MARCH 1973, JUNE 1973

SPECIES / Sample Stations and Numbers →	1A D	1A M	1A J	1B D	1B M	1B J	1C D	1C M	1C J	1D D	1D M	1D J	S1A D	S1A M	S1A J	S1B D	S1B M	S1B J	S1C D	S1C M	S1C J	S1D D	S1D M	S1D J
Actinara																								
Nemertea																								
Oligochaeta																								
Limnodrilus hoffmeisteri									2					7						1				
Peloscolex apectinatus																								
Peloscolex gabriellae																								
Peloscolex nerthoides																								
Peloscolex sp.														20	17		14	23		21	7		26	20
Polychaeta																								
Capitella capitata			1															3						
Cossura sp.																								
Eteone lighti												3			2			5		1	7			
Glycinde sp.																								
Harmothoe imbricata																								
Heteromastus filiformis		1			3				2		1	1			1									
?Laonide sp.																								
Mediomastus californiensis																								
Neanthes limnicola																								
Neanthes succinea						1						1												
Nephtys caecoides																								
Nereis sp.																								
Nerine cirratulus																								
Nerinides sp.																								
Polydora ligni																								
Polydora sp.																								
Pseudopolydora kempi						4					3	1		4	2			5			10			5
Pseudopolydora paucibranchiata																								
Pygospio elegans																								
Scoloplos acmeceps																								
Spionidae, unidentified																							1	
Streblospio benedicti						1		2				1		23	25		29	43		25	25		26	26
Syllidae																								
Ostracoda																								
Copepoda																								
Isopoda																								
Gnorimosphaeroma lutea																								
Isopoda, unidentified																								
Chelifera																								
Leptochelia dubia																								
Tanais vanis																								
Amphipoda																								
Ampelisca milleri			10			12			8			11			15			15			3			9
Ampithoe lacertosa																								
Ampithoe valida																								
Corophium acherusicum																								
Corophium insidiosum			7			7			1			6			12			20			12			24
Corophium spinicorne			2						2			1			3			1			1			
Corophium sp.																								
Grandidierella japonica		4	56		4	68		7	63		1	76			32			47		1	51			55
Orchestia sp.														1			1							
Melita sp.												1												
Insecta																								
Gastropoda																								
Nassarius obsoletus																								
Bivalvia																								
Gemma gemma			7			23			8			20			2			4			4			4
Macoma balthica			22		1	26			20			34			5			5			6			5
Modiolus senhousia																								
Mya arenaria			1			1		1	1			5						1			1			
Mytilus edulis																								
Tapes japonica																								
Holothuroidea																								
Fish																								

SPECIES / Sample Stations and Numbers →	3A D	3A M	3A J	3B D	3B M	3B J	3C D	3C M	3C J	3D D	3D M	3D J	S3A D	S3A M	S3A J	S3B D	S3B M	S3B J	S3C D	S3C M	S3C J	S3D D	S3D M	S3D J
Actinara																								
Nemertea																								
Oligochaeta																								
Limnodrilus hoffmeisteri																					4			1
Peloscolex apectinatus																								
Peloscolex gabriellae																								
Peloscolex nerthoides																								
Peloscolex sp.					1								138	14	12	80	1	5	137	5	2		2	9
Polychaeta																								
Capitella capitata													2			2			3					
Cossura sp.																								
Eteone lighti	6			3			2						3		2	3		3	5	2				
Glycinde sp.																								
Harmothoe imbricata																					1			
Heteromastus filiformis					3									1	1			1			1			
?Laonide sp.																								
Mediomastus californiensis																								
Neanthes limnicola																								
Neanthes succinea																		1						
Nephtys caecoides																								
Nereis sp.					2																			
Nerine cirratulus																								
Nerinides sp.																								
Polydora ligni																								
Polydora sp.	1						3						1											
Pseudopolydora kempi														1	1	3		3			1		2	1
Pseudopolydora paucibranchiata				1																				
Pygospio elegans																								
Scoloplos acmeceps																								
Spionidae, unidentified																								
Streblospio benedicti	40						1						99	10	23	34	5	3	89	13	2		21	1
Syllidae																		26						
Ostracoda																		5			17			17
Copepoda																								
Isopoda																								
Gnorimosphaeroma lutea																								
Isopoda, unidentified																								
Chelifera																								
Leptochelia dubia																								
Tanais vanis																								
Amphipoda																								
Ampelisca milleri															2			3			2			2
Ampithoe lacertosa																								
Ampithoe valida																								
Corophium acherusicum																								
Corophium insidiosum															29			42			35			42
Corophium spinicorne															2									
Corophium sp.																		1						
Grandidierella japonica														1	40			24			20			37
Orchestia sp.																								
Melita sp.																								
Insecta																								
Gastropoda																								
Nassarius obsoletus																								
Bivalvia																								
Gemma gemma	209		32		4	17		9	39		5	29	1	2	4		2	3		3	4		3	8
Macoma balthica			11		2	17		5	15		3	20			2			4			3			3
Modiolus senhousia																								
Mya arenaria	3		3		1	1			4		2	4		1				2			1			1
Mytilus edulis																								
Tapes japonica																								
Holothuroidea																								
Fish																								

BENTHIC INVERTEBRATE FAUNA, SAN QUENTIN MUD FLAT
CORTE MADERA BAY, MARIN COUNTY, CALIFORNIA
DECEMBER 1972, MARCH 1973, JUNE 1973

SPECIES / Sample Stations and Numbers →	K3A			K3B			K3C			K3D			KS3A			KS3B			KS3C			KS3D		
	D	M	J	D	M	J	D	M	J	D	M	J	D	M	J	D	M	J	D	M	J	D	M	J
Actinara																								
Nemertea																								
Oligochaeta																								
Limnodrilus hoffmeisteri																								
Peloscolex apectinatus																								
Peloscolex gabriellae																								
Peloscolex nerthoides																								
Peloscolex sp.															19			11			25			33
Polychaeta																								
Capitella capitata																								
Cossura sp.																								
Eteone lighti															1						1			1
Glycinde sp.																								
Harmothoe imbricata																								
Heteromastus filiformis			1			4						4			1						3			1
?Laonide sp.																								
Mediomastus californiensis																								
Neanthes limnicola																								
Neanthes succinea																								
Nephtys caecoides																								
Nereis sp.																								
Nerine cirratulus																								
Nerinides sp.																								
Polydora ligni																								
Polydora sp.																								
Pseudopolydora kempi															2			1			1			2
Pseudopolydora paucibranchiata																								
Pygospio elegans																								
Scoloplos acmeceps																								
Spionidae, unidentified																								
Streblospio benedicti															23			28			3			27
Syllidae																								
Ostracoda																		2			2			
Copepoda																								
Isopoda																								
Gnorimosphaeroma lutea																								
Isopoda, unidentified																								
Chelifera																								
Leptochelia dubia																								
Tanais vanis																		1						
Amphipoda																								
Ampelisca milleri															5			1			17			3
Ampithoe lacertosa																								
Ampithoe valida																								
Corophium acherusicum																								
Corophium insidiosum															30			27			30			11
Corophium spinicorne															1			2						
Corophium sp.																								
Grandidierella japonica															36			19			59			26
Orchestia sp.																								
Melita sp.																								
Insecta																								
Gastropoda																								
Nassarius obsoletus																								
Bivalvia																								
Gemma gemma			14			15			10			12			4			13			15			10
Macoma balthica			18			26			33			20			4			5			22			3
Modiolus senhousia									1															
Mya arenaria			5			2			3									3			4			2
Mytilus edulis																								
Tapes japonica																								
Holothuroidea																								
Fish																								

SPECIES / Sample Stations and Numbers →	4A			4B			4C			4D			S4A			S4B			S4C			S4D		
	D	M	J	D	M	J	D	M	J	D	M	J	D	M	J	D	M	J	D	M	J	D	M	J
Actinara																								
Nemertea																								
Oligochaeta																								
Limnodrilus hoffmeisteri		2									2			2			4			7			8	
Peloscolex apectinatus																								
Peloscolex gabriellae																								
Peloscolex nerthoides																								
Peloscolex sp.				1		2		3				6	12	9	21	6	6	18	28	1	32			17
Polychaeta																								
Capitella capitata							2																	
Cossura sp.																								
Eteone lighti							2						3			4			1					1
Glycinde sp.																								
Harmothoe imbricata																								
Heteromastus filiformis				1																				
?Laonide sp.																								
Mediomastus californiensis																								
Neanthes limnicola																								
Neanthes succinea																								
Nephtys caecoides																								
Nereis sp.																								
Nerine cirratulus																								
Nerinides sp.																								
Polydora ligni																								
Polydora sp.																								
Pseudopolydora kempi			2												1						1			
Pseudopolydora paucibranchiata																								
Pygospio elegans																								
Scoloplos acmeceps																								
Spionidae, unidentified																								
Streblospio benedicti		2		26			14	3			4		304	67		69	15	1	105	22	1		23	
Syllidae																								
Ostracoda															118			46			27			41
Copepoda																								
Isopoda																								
Gnorimosphaeroma lutea																								
Isopoda, unidentified																								
Chelifera																								
Leptochelia dubia																								
Tanais vanis													1											
Amphipoda																								
Ampelisca milleri													1											
Ampithoe lacertosa																								
Ampithoe valida																								
Corophium acherusicum																								
Corophium insidiosum															3									
Corophium spinicorne																								
Corophium sp.																								
Grandidierella japonica																								
Orchestia sp.																								
Melita sp.																								
Insecta																								
Gastropoda																								
Nassarius obsoletus																								
Bivalvia																								
Gemma gemma							1																	
Macoma balthica						1			1			1			1									1
Modiolus senhousia																								
Mya arenaria					1																			
Mytilus edulis																								
Tapes japonica																								
Holothuroidea																								
Fish																								

NATIONAL 42-385

BENTHIC INVERTEBRATE FAUNA, SAN QUENTIN MUD FLAT
CORTE MADERA BAY, MARIN COUNTY, CALIFORNIA
DECEMBER 1972, MARCH 1973, JUNE 1973

SPECIES — Sample Stations and Numbers→	K4A			K4B			K4C			K4D			KS4A			KS4B			KS4C			KS4D		
	D	M	J	D	M	J	D	M	J	D	M	J	D	M	J	D	M	J	D	M	J	D	M	J
Actinara																								
Nemertea																								
Oligochaeta																								
Limnodrilus hoffmeisteri																								
Peloscolex apectinatus																								
Peloscolex gabriellae																								
Peloscolex nerthoides																								
Peloscolex sp.						4						3			12			19			10			30
Polychaeta																								
Capitella capitata																								
Cossura sp.																								
Eteone lighti																								
Glycinde sp.																								
Harmothoe imbricata																								
Heteromastus filiformis																								
?Laonice sp.																								
Mediomastus californiensis																								
Neanthes limnicola																								
Neanthes succinea															1									
Nephtys caecoides																								
Nereis sp.																								
Nerine cirratulus																								
Nerinides sp.																								
Polydora ligni						1																		2
Polydora sp.																								
Pseudopolydora kempi						2						4			2			3						8
Pseudopolydora paucibranchiata																								
Pygospio elegans																								
Scoloplos acmeceps																								
Spionidae, unidentified																								
Streblospio benedicti												1			1			2						
Syllidae																								
Ostracoda															65			37			42			15
Copepoda																								
Isopoda																								
Gnorimosphaeroma lutea																								
Isopoda, unidentified																								
Chelifera																								
Leptochelia dubia																								
Tanais vanis																								
Amphipoda																								
Ampelisca milleri																								
Ampithoe lacertosa																								
Ampithoe valida																								
Corophium acherusicum																								
Corophium insidiosum															5			8			2			
Corophium spinicorne																								
Corophium sp.																								
Grandidierella japonica																								
Orchestia sp.																								
Melita sp.																								
Insecta																								
Gastropoda																								
Nassarius obsoletus																								
Bivalvia																								
Gemma gemma																								
Macoma balthica			3			2			1			2			2			1			1			1
Modiolus senhousia												1												
Mya arenaria			1						1									1						
Mytilus edulis																								
Tapes japonica																								
Holothuroidea																								
Fish																								

SPECIES — Sample Stations and Numbers→	5A			5B			5C			5D			S5A			S5B			S5C			S5D		
	D	M	J	D	M	J	D	M	J	D	M	J	D	M	J	D	M	J	D	M	J	D	M	J
Actinara																								
Nemertea																								
Oligochaeta																								
Limnodrilus hoffmeisteri																								
Peloscolex apectinatus		1																1			2			
Peloscolex gabriellae											1				1		1						5	3
Peloscolex nerthoides		9			1	4						3					1				1		8	
Peloscolex sp.	1			9		1			3			5	7		6	14		1			1			5
Polychaeta																								
Capitella capitata																							1	
Cossura sp.																1								
Eteone lighti					1	5	3	3	3			3	1	2		1	1	3	1		1			1
Glycinde sp.	1			2			1																	
Harmothoe imbricata									1															
Heteromastus filiformis									1															
?Laonice sp.																								
Mediomastus californiensis																								
Neanthes limnicola							1																	
Neanthes succinea																								
Nephtys caecoides																								
Nereis sp.					2						1													
Nerine cirratulus																								
Nerinides sp.									1			1												
Polydora ligni		1						1									1							
Polydora sp.				1			4																	
Pseudopolydora kempi	2		3	3		5	1		2			3		1	1									
Pseudopolydora paucibranchiata																								
Pygospio elegans																								
Scoloplos acmeceps																								
Spionidae, unidentified																								
Streblospio benedicti	20	4	9	12	2	18	54	4	19		1	27	23	33	1	7	28	2	5	24	20		54	26
Syllidae																								
Ostracoda							1																	
Copepoda																								
Isopoda																								
Gnorimosphaeroma lutea																								
Isopoda, unidentified																								
Chelifera																								
Leptochelia dubia																								
Tanais vanis													1											
Amphipoda																								
Ampelisca milleri	51	9		16	12		13	5	1				5		119	1	2	137	4	2	131		2	155
Ampithoe lacertosa																								
Ampithoe valida																								
Corophium acherusicum															13			4			12			4
Corophium insidiosum				1											139			88			113			129
Corophium spinicorne															8			10			11			10
Corophium sp.																								
Grandidierella japonica	24	3		15	5		14	1					7		15	1		16	12		16			32
Orchestia sp.																								
Melita sp.	1																							
Insecta																								
Gastropoda																								
Nassarius obsoletus																								
Bivalvia																								
Gemma gemma	41		199	15	13	336		6	226			192			66			57			88			88
Macoma balthica			2																					
Modiolus senhousia																								
Mya arenaria	5		8			29		3	9		2	20		1	3			10			6			5
Mytilus edulis									4															
Tapes japonica																								
Holothuroidea																								
Fish																								

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SPECIES / Sample Stations and Numbers→	6A D	6A M	6A J	6B D	6B M	6B J	6C D	6C M	6C J	6D D	6D M	6D J	S6A D	S6A M	S6A J	S6B D	S6B M	S6B J
Actinara						1						1						
Nemertea																		
Oligochaeta																		
Limnodrilus hoffmeisteri														3				
Peloscolex apectinatus																		
Peloscolex gabriellae						1									6		4	5
Peloscolex nerthoides																		
Peloscolex sp.	10			1									33					
Polychaeta																		
Capitella capitata																		
Cossura sp.																		
Eteone lighti	1			1		3								5				2
Glycinde sp.	2			1												1		
Harmothoe imbricata																		
Heteromastus filiformis	2	1	2		4	5		1	1		3	5		1				1
?Laonice sp.																		
Mediomastus californiensis																		
Neanthes limnicola																		
Neanthes succinea																		
Nephtys caecoides																		
Nereis sp.																		
Nerine cirratulus																		
Nerinides sp.												1						
Polydora ligni																		
Polydora sp.													1					
Pseudopolydora kempi	2			7	3	2		1			1	1	1	2			2	1
Pseudopolydora paucibranchiata																		
Pygospio elegans														1				
Scoloplos acmeceps				1														
Spionidae, unidentified																		
Streblospio benedicti	17	1		30		2		1			6		53	94	1		33	2
Syllidae																		
Ostracoda				3									3					
Copepoda																		
Isopoda																		
Gnorimosphaeroma lutea																		
Isopoda, unidentified																		
Chelifera																		
Leptochelia dubia																		
Tanais vanis																		
Amphipoda																		
Ampelisca milleri	30			95									8		17	9		31
Ampithoe lacertosa																		
Ampithoe valida																		
Corophium acherusicum																		
Corophium insidiosum		4		1				1							26			34
Corophium spinicorne		1			1			2			1			1	8			2
Corophium sp.																		1
Grandidierella japonica	7	7		17	3			3			7		12	1	22			39
Orchestia sp.																		
Melita sp.																		
Insecta																		
Gastropoda																		
Nassarius obsoletus																		
Bivalvia																		
Gemma gemma	73	4	23	75	2	38		31	18		8	9	18		8			5
Macoma balthica		2	23			22		1	30			23			6			5
Modiolus senhousia																		
Mya arenaria	1		7	3	2	7			9		2	4	1		2			4
Mytilus edulis																		
Tapes japonica	1																	
Holothuroidea																		
Fish																		

SPECIES	S6C D	S6C M	S6C J	S6D D	S6D M	S6D J	7A D	7A M	7A J	7B D	7B M	7B J	7C D	7C M	7C J
Actinara															
Nemertea														1	
Oligochaeta															
Limnodrilus hoffmeisteri															
Peloscolex apectinatus															
Peloscolex gabriellae		7	8		2	30									
Peloscolex nerthoides															
Peloscolex sp.	10									1			1		
Polychaeta											1				
Capitella capitata															
Cossura sp.															
Eteone lighti		2	4		1			1				1			5
Glycinde sp.															
Harmothoe imbricata															
Heteromastus filiformis									1		1			1	2
?Laonice sp.															
Mediomastus californiensis							1								
Neanthes limnicola															
Neanthes succinea												1			
Nephtys caecoides							1								
Nereis sp.															
Nerine cirratulus															
Nerinides sp.															
Polydora ligni															
Polydora sp.															
Pseudopolydora kempi		1	1		1	1		1						2	1
Pseudopolydora paucibranchiata															
Pygospio elegans		1			1	1								1	
Scoloplos acmeceps															
Spionidae, unidentified															
Streblospio benedicti	18	60			64	4							1		24
Syllidae															
Ostracoda															
Copepoda															
Isopoda															
Gnorimosphaeroma lutea															
Isopoda, unidentified															
Chelifera															
Leptochelia dubia															
Tanais vanis															
Amphipoda															
Ampelisca milleri	4		27			10			3						
Ampithoe lacertosa															
Ampithoe valida															
Corophium acherusicum															
Corophium insidiosum		1	47		2	31			17						
Corophium spinicorne			2		1										
Corophium sp.									1						
Grandidierella japonica	2	5	41		1	41	1		47	4			2	1	
Orchestia sp.															
Melita sp.															
Insecta															
Gastropoda															
Nassarius obsoletus															
Bivalvia															
Gemma gemma	2	12	5		1	6	156	15	55	278	16	70	196	18	69
Macoma balthica			8			6		2	6		5	11		7	13
Modiolus senhousia															
Mya arenaria			3			2		1	5		1	6		1	5
Mytilus edulis															
Tapes japonica															
Holothuroidea															
Fish															

SPECIES	7D D	7D M	7D J	S7A D	S7A M	S7A J	S7B D	S7B M	S7B J	S7C D	S7C M	S7C J	S7D D	S7D M	S7D J
Actinara			2			1									
Nemertea															
Oligochaeta														1	
Limnodrilus hoffmeisteri														5	
Peloscolex apectinatus															
Peloscolex gabriellae					11						1				
Peloscolex nerthoides															
Peloscolex sp.				10			6		3			1			1
Polychaeta															
Capitella capitata					1				2			2			
Cossura sp.															
Eteone lighti		2	1		2	5		2	4			4		2	3
Glycinde sp.															
Harmothoe imbricata															
Heteromastus filiformis				1		1		1	1						
?Laonice sp.						1									
Mediomastus californiensis															
Neanthes limnicola															
Neanthes succinea			1						2						1
Nephtys caecoides															
Nereis sp.															
Nerine cirratulus			1												
Nerinides sp.															
Polydora ligni															
Polydora sp.															
Pseudopolydora kempi		1		5		24		5	6		3	2		4	
Pseudopolydora paucibranchiata															
Pygospio elegans		1	17		4	17		10	43		6	14		5	2
Scoloplos acmeceps															
Spionidae, unidentified															
Streblospio benedicti				35	31	13		7	13	6	11	1		24	1
Syllidae															
Ostracoda															
Copepoda															
Isopoda															
Gnorimosphaeroma lutea															
Isopoda, unidentified															
Chelifera															
Leptochelia dubia															
Tanais vanis															
Amphipoda															
Ampelisca milleri						2			4			3			
Ampithoe lacertosa															1
Ampithoe valida															
Corophium acherusicum															
Corophium insidiosum						64		1	55			64			73
Corophium spinicorne															
Corophium sp.									1			1			
Grandidierella japonica		1		15	1	58	12		47	2		60			68
Orchestia sp.															
Melita sp.															
Insecta															
Gastropoda															
Nassarius obsoletus															
Bivalvia															
Gemma gemma		10	88	89	7	16	21		11	90	7	6		12	26
Macoma balthica		4			2	1		1	3		1	1		1	1
Modiolus senhousia															
Mya arenaria		2	6			2			1		2				1
Mytilus edulis															
Tapes japonica															
Holothuroidea															
Fish															

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SPECIES / Sample Stations and Numbers →	8A			8B			8C			S8A			S8B			S8C		
	D	M	J	D	M	J	D	M	J	D	M	J	D	M	J	D	M	J
Actinaria																		
Nemertea																		
Oligochaeta																		
Limnodrilus hoffmeisteri																		
Peloscolex apectinatus																		
Peloscolex gabriellae																		
Peloscolex nerthoides																		
Peloscolex sp.													4			1		
Polychaeta																		
Capitella capitata																		
Cossura sp.																		
Eteone lighti				1						3			2					
Glycinde sp.																		
Harmothoe imbricata																		
Heteromastus filiformis																		
?*Laonice* sp.																		
Mediomastus californiensis																		
Neanthes limnicola																		
Neanthes succinea																		
Nephtys caecoides																		
Nereis sp.																		
Nerine cirratulus																		
Nerinides sp.																		
Polydora ligni																		
Polydora sp.																		
Pseudopolydora kempi																		
Pseudopolydora paucibranchiata																		
Pygospio elegans																		
Scoloplos acmeceps																		
Spionidae, unidentified																		
Streblospio benedicti										12			4			5		
Syllidae																		
Ostracoda													1					
Copepoda																		
Isopoda																		
Gnorimosphaeroma lutea																		
Isopoda, unidentified																		
Chelifera																		
Leptochelia dubia																		
Tanais vanis																		
Amphipoda																		
Ampelisca milleri	1									1			16					
Ampithoe lacertosa																		
Ampithoe valida																		
Corophium acherusicum																		
Corophium insidiosum										2								
Corophium spinicorne																		
Corophium sp.																		
Grandidierella japonica	4			1									11			2		
Orchestia sp.																		
Melita sp.																		
Insecta																		
Gastropoda																		
Nassarius obsoletus																		
Bivalvia																		
Gemma gemma				209			260			361			33			14		
Macoma balthica							2			1			1			1		
Modiolus senhousia																		
Mya arenaria																		
Mytilus edulis																		
Tapes japonica																		
Holothuroidea																		
Fish																		

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SPECIES — Sample Stations and Numbers →	9A			9B			9C			9D			S9A			S9B			S9C			S9D			10A			10B			10C			10D			S10A			S10B			S10C			S10D		
	D	M	J	D	M	J	D	M	J	D	M	J	D	M	J	D	M	J	D	M	J	D	M	J	D	M	J	D	M	J	D	M	J	D	M	J	D	M	J	D	M	J	D	M	J	D	M	J
Actinara																																																
Nemertea																																																
Oligochaeta														/																																		
Limnodrilus hoffmeisteri															7			19			33			90																		9			6			
Peloscolex apectinatus																																																
Peloscolex gabriellae																																																
Peloscolex nerthoides																					/																											
Peloscolex sp.																																																
Polychaeta																																																
Capitella capitata																																																
Cossura sp.																																																
Eteone lighti														/																										/								
Glycinde sp.																																																
Harmothoe imbricata																																																
Heteromastus filiformis																																																
?Laonice sp.																																																
Mediomastus californiensis																																																
Neanthes limnicola																																																
Neanthes succinea																																																
Nephtys caecoides																																																
Nereis sp.																																																
Nerine cirratulus																																																
Nerinides sp.																																																
Polydora ligni																																																
Polydora sp.																																																
Pseudopolydora kempi																																																
Pseudopolydora paucibranchiata																																																
Pygospio elegans																																																
Scoloplos acmeceps																																																
Spionidae, unidentified																																																
Streblospio benedicti																					/											/																
Syllidae																																																
Ostracoda																																																
Copepoda																																																
Isopoda																																																
Gnorimosphaeroma lutea																		/																														
Isopoda, unidentified																																																
Chelifera																																																
Leptochelia dubia																																																
Tanais vanis																																																
Amphipoda																																																
Ampelisca milleri																																																
Ampithoe lacertosa																																																
Ampithoe valida																																																
Corophium acherusicum																																																
Corophium insidiosum																																																
Corophium spinicorne																																																
Corophium sp.																																																
Grandidierella japonica																																																
Orchestia sp.																																																
Melita sp.																																																
Insecta																																																
Gastropoda																																																
Nassarius obsoletus																																																
Bivalvia																																																
Gemma gemma																																																
Macoma balthica																																																
Modiolus senhousia																																																
Mya arenaria																																																
Mytilus edulis																																																
Tapes japonica																																																
Holothuroidea																																																
Fish																																																

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SPECIES / Sample Stations and Numbers	11A			11B			11C			11D		
	D	M	J	D	M	J	D	M	J	D	M	J
Actinara												
Nemertea												
Oligochaeta												
Limnodrilus hoffmeisteri												
Peloscolex apectinatus												
Peloscolex gabriellae												
Peloscolex nerthoides												
Peloscolex sp.						/			/			
Polychaeta												
Capitella capitata			/			9						/
Cossura sp.												
Eteone lighti			3			4			4			10
Glycinde sp.												
Harmothoe imbricata			/									
Heteromastus filiformis												
?Laonice sp.												
Mediomastus californiensis												
Neanthes limnicola												
Neanthes succinea												
Nephtys caecoides												
Nereis sp.												
Nerine cirratulus												
Nerinides sp.												
Polydora ligni												
Polydora sp.												
Pseudopolydora kempi			27			9			38			20
Pseudopolydora paucibranchiata												
Pygospio elegans												
Scoloplos acmeceps												
Spionidae, unidentified												
Streblospio benedicti			2						2			/
Syllidae												
Ostracoda												
Copepoda												
Isopoda												
Gnorimosphaeroma lutea												
Isopoda, unidentified												
Chelifera												
Leptochelia dubia												
Tanais vanis												
Amphipoda												
Ampelisca milleri												
Ampithoe lacertosa												
Ampithoe valida												
Corophium acherusicum												
Corophium insidiosum												
Corophium spinicorne												
Corophium sp.												
Grandidierella japonica												
Orchestia sp.												
Melita sp.												
Insecta								2				
Gastropoda												
Nassarius obsoletus												
Bivalvia												
Gemma gemma												
Macoma balthica			2			/			/			5
Modiolus senhousia												
Mya arenaria			/									
Mytilus edulis												
Tapes japonica												
Holothuroidea												
Fish												

SPECIES / Sample Stations and Numbers	S11A			S11B			S11C			S11D		
	D	M	J	D	M	J	D	M	J	D	M	J
Actinara												
Nemertea												
Oligochaeta												
Limnodrilus hoffmeisteri												
Peloscolex apectinatus												
Peloscolex gabriellae											/	
Peloscolex nerthoides			/									
Peloscolex sp.												
Polychaeta												
Capitella capitata			/			5			/			4
Cossura sp.												
Eteone lighti			7			4		/				5
Glycinde sp.												
Harmothoe imbricata												
Heteromastus filiformis												
?Laonice sp.												
Mediomastus californiensis												
Neanthes limnicola						/						
Neanthes succinea												
Nephtys caecoides												
Nereis sp.												
Nerine cirratulus												
Nerinides sp.												
Polydora ligni						/			/			
Polydora sp.												
Pseudopolydora kempi			20			64			44			37
Pseudopolydora paucibranchiata						/						/
Pygospio elegans												
Scoloplos acmeceps												
Spionidae, unidentified												
Streblospio benedicti			/		/	2						2
Syllidae												
Ostracoda												
Copepoda												
Isopoda												
Gnorimosphaeroma lutea												
Isopoda, unidentified												
Chelifera												
Leptochelia dubia												
Tanais vanis												
Amphipoda												
Ampelisca milleri			15			7			13			14
Ampithoe lacertosa												
Ampithoe valida												
Corophium acherusicum												
Corophium insidiosum			20			5			10			13
Corophium spinicorne			2			2			4			16
Corophium sp.												
Grandidierella japonica						/						26
Orchestia sp.												
Melita sp.												
Insecta		/										
Gastropoda												
Nassarius obsoletus												
Bivalvia												
Gemma gemma			/						3			
Macoma balthica			2						2			/
Modiolus senhousia												
Mya arenaria												
Mytilus edulis												
Tapes japonica												
Holothuroidea												
Fish												

SPECIES / Sample Stations and Numbers	12A			12B			12C			12D		
	D	M	J	D	M	J	D	M	J	D	M	J
Actinara												
Nemertea												
Oligochaeta												
Limnodrilus hoffmeisteri												
Peloscolex apectinatus												
Peloscolex gabriellae												
Peloscolex nerthoides												
Peloscolex sp.												
Polychaeta												
Capitella capitata												/
Cossura sp.												
Eteone lighti			7		/	/						
Glycinde sp.			/			2						2
Harmothoe imbricata												
Heteromastus filiformis		/				2		/	/			
?Laonice sp.												
Mediomastus californiensis												
Neanthes limnicola												
Neanthes succinea											/	
Nephtys caecoides												
Nereis sp.												
Nerine cirratulus												
Nerinides sp.												/
Polydora ligni												
Polydora sp.												
Pseudopolydora kempi			/		2			/			/	2
Pseudopolydora paucibranchiata												
Pygospio elegans												
Scoloplos acmeceps												
Spionidae, unidentified												
Streblospio benedicti			3		8			3			4	2
Syllidae												
Ostracoda												
Copepoda												
Isopoda												
Gnorimosphaeroma lutea												
Isopoda, unidentified												
Chelifera												
Leptochelia dubia												
Tanais vanis												
Amphipoda												
Ampelisca milleri												
Ampithoe lacertosa												
Ampithoe valida												
Corophium acherusicum												
Corophium insidiosum		/										
Corophium spinicorne												
Corophium sp.												
Grandidierella japonica		2			2			2			3	
Orchestia sp.												
Melita sp.												
Insecta												
Gastropoda												
Nassarius obsoletus												
Bivalvia												
Gemma gemma		17	616		21	554		24	589		33	603
Macoma balthica			3			7			3			5
Modiolus senhousia												
Mya arenaria			7			10			3			10
Mytilus edulis												
Tapes japonica												
Holothuroidea												
Fish												

SPECIES / Sample Stations and Numbers	S12A			S12B			S12C			S12D		
	D	M	J	D	M	J	D	M	J	D	M	J
Actinara									/			
Nemertea												
Oligochaeta												
Limnodrilus hoffmeisteri												
Peloscolex apectinatus												
Peloscolex gabriellae								/	/		4	2
Peloscolex nerthoides												
Peloscolex sp.			4			5			5			17
Polychaeta												
Capitella capitata											/	
Cossura sp.												
Eteone lighti		/	/		2	2			3		/	6
Glycinde sp.			/						/			/
Harmothoe imbricata												
Heteromastus filiformis						/						
?Laonice sp.												
Mediomastus californiensis												
Neanthes limnicola												
Neanthes succinea												
Nephtys caecoides												
Nereis sp.												
Nerine cirratulus												
Nerinides sp.												
Polydora ligni												
Polydora sp.												
Pseudopolydora kempi			36		/	28		/	16			23
Pseudopolydora paucibranchiata												
Pygospio elegans												
Scoloplos acmeceps												
Spionidae, unidentified												
Streblospio benedicti		48	51		30	88		63	87		39	106
Syllidae												
Ostracoda												
Copepoda						/						
Isopoda												
Gnorimosphaeroma lutea												
Isopoda, unidentified												
Chelifera												
Leptochelia dubia												
Tanais vanis												
Amphipoda												
Ampelisca milleri			71			43			106			71
Ampithoe lacertosa												
Ampithoe valida												
Corophium acherusicum									/			3
Corophium insidiosum			33			32			43			54
Corophium spinicorne									2			3
Corophium sp.												
Grandidierella japonica						11		/	10			15
Orchestia sp.												
Melita sp.												
Insecta												
Gastropoda												
Nassarius obsoletus												
Bivalvia												
Gemma gemma		13	64			109		9	116		16	117
Macoma balthica						/		2	2			
Modiolus senhousia												
Mya arenaria			2			/			4			2
Mytilus edulis												
Tapes japonica												
Holothuroidea												
Fish												

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CORTE MADERA BAY, MARIN COUNTY, CALIFORNIA
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SPECIES / Sample Stations and Numbers	13A			13B			13C			13D			S13A			S13B			S13C			S13D			K13A			K13B			K13C			K13D			ES13A			ES13B			ES13C			ES13D		
	D	M	J	D	M	J	D	M	J	D	M	J	D	M	J	D	M	J	D	M	J	D	M	J	D	M	J	D	M	J	D	M	J	D	M	J	D	M	J	D	M	J	D	M	J	D	M	J
Actinara															1																																	
Nemertea																																																
Oligochaeta																																																
Limnodrilus hoffmeisteri																																							1									
Peloscolex apectinatus																																																
Peloscolex gabriellae					1																																											
Peloscolex nerthoides																																																
Peloscolex sp.			1												19						1																		3			35			2			18
Polychaeta																																																
Capitella capitata																																																
Cossura sp.																																																
Eteone lighti			2		2	1		1	1		1	1		2	3			1		2	1			1															3						5	1		1
Glycinde sp.																																																
Harmothoe imbricata																																																
Heteromastus filiformis		1	3		1	2		2	5		1	3		1	2		1	2		1							3			4			4			4			1			1			2			
?Laonice sp.																																																
Mediomastus californiensis																																																
Neanthes limnicola																																																
Neanthes succinea																																																
Nephtys caecoides																																																
Nereis sp.																																																
Nerine cirratulus																																																
Nerinides sp.																																																
Polydora ligni																																																
Polydora sp.																																																
Pseudopolydora kempi					14	2		1			1				8		9	2			1		2																26									1
Pseudopolydora paucibranchiata																																																
Pygospio elegans			1			1			1						5		1	1		1			3																4									
Scoloplos acmeceps																																																
Spionidae, unidentified																																																
Streblospio benedicti			2		43	1								64	107		43	1		60	3		43	2															1			1			2			2
Syllidae																																																
Ostracoda																																																
Copepoda																																																
Isopoda																																																
Gnorimosphaeroma lutea																																																
Isopoda, unidentified																																																
Chelifera																																																
Leptochelia dubia																																																
Tanais vanis																																																
Amphipoda																																																
Ampelisca milleri															3									6															2			4			1			
Ampithoe lacertosa																																																
Ampithoe valida																																																
Corophium acherusicum																																																
Corophium insidiosum															48			19			20		1	23															29			37			39			43
Corophium spinicorne		2												1																						1												
Corophium sp.					1	1					2																																		1			1
Grandidierella japonica		3			2			3			4			1	37			14			23		1	25															55			53			67			55
Orchestia sp.																																																
Melita sp.																																																
Insecta																																																
Gastropoda																																																
Nassarius obsoletus																																				3						1						
Bivalvia																																																
Gemma gemma		16	84		3	38		9	88		12	66		3	23		2	8		2	26			6			87			112			132			119			60			34			33			41
Macoma balthica			14			21		1	12		1	21			4			3			5			2			23			40			54			39			10			7			11			6
Modiolus senhousia																																																
Mya arenaria		1	2	1		4		1	4		1	5			1			1						1			6			2			6			3												
Mytilus edulis																																													1			
Tapes japonica																																																
Holothuroidea																																																
Fish																																																

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SPECIES / Sample Stations and Numbers	14A			14B			14C			14D			S14A			S14B			S14C			S14D			K14A			K14B			K14C			K14D			KS14A			KS14B			KS14C			KS14D		
	D	M	J	D	M	J	D	M	J	D	M	J	D	M	J	D	M	J	D	M	J	D	M	J	D	M	J	D	M	J	D	M	J	D	M	J	D	M	J	D	M	J	D	M	J	D	M	J
Actinara												1								1	1						1			1																		
Nemertea																																										1						
Oligochaeta																																																
Limnodrilus hoffmeisteri																																																
Peloscolex apectinatus																																																
Peloscolex gabriellae																																																
Peloscolex nerthoides																																																
Peloscolex sp.															6			11			2			5															13			10			16			11
Polychaeta																																																
Capitella capitata																								1															2			1			2			5
Cossura sp.																																																
Eteone lighti														2	2					1	2		2	2						1									3			5						6
Glycinde sp.																																																
Harmothoe imbricata																																																
Heteromastus filiformis		1			1	1		2	1		2	1			1			2		1	1		1	1			3			1			1			1			2			1			1			
?Laonice sp.																																																
Mediomastus californiensis																																																
Neanthes limnicola																																																
Neanthes succinea																																	1															
Nephtys caecoides																																																
Nereis sp.																																																
Nerine cirratulus																																																
Nerinides sp.																																																
Polydora ligni																																																
Polydora sp.																																																
Pseudopolydora kempi		1										1		2			3	2		4	1		4																1			1						3
Pseudopolydora paucibranchiata																																																
Pygospio elegans														1	20		7			1	3		5																14			5			13			2
Scoloplos acmeceps																																																
Spionidaa, unidentified																																																
Streblospio benedicti														23	4		9	1		4	8		17	1															14			12			7			17
Syllidae																																																
Ostracoda																																																
Copepoda																																																
Isopoda																																																
Gnorimosphaeroma lutea																																																
Isopoda, unidentified																																																
Chelifera																																																
Leptochelia dubia																																																
Tanais vanis																																																
Amphipoda																																																
Ampelisca milleri																		1																								4						33
Ampithoe lacertosa																																																
Ampithoe valida																																										2						
Corophium acherusicum																																																
Corophium insidiosum					2			1			1				64		4	122			37		2	51															54			165			48			41
Corophium spinicorne					1						1			2				2					1																									
Corophium sp.																					31			10															14			3			69			35
Grandidierella japonica		13			9			5			9			7			1			3			4																18			32			9			42
Orchestia sp.																																																
Melita sp.																																																
Insecta																																																
Gastropoda																																																
Nassarius obsoletus						1																					4			1			1															
Bivalvia																																																
Gemma gemma		8	88		17	39		27	51		8	70		6	9		9	20		7	13		4	27			36			13			32			24			14			8			11			21
Macoma balthica		3	11			9		7	14		8	10		1	14		1	3			2			2			16			9			11			7			2			3			2			5
Modiolus senhousia												1																																				
Mya arenaria		1	7		1	7		4	6		4	7						1			1			1			2			3			7			1									3			2
Mytilus edulis																																																
Tapes japonica																																																
Holothuroidea																																							1									
Fish																																																

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SPECIES / Sample Stations and Numbers	15A			15B			15C			15D			S15A			S15B			S15C			S15D		
	D	M	J	D	M	J	D	M	J	D	M	J	D	M	J	D	M	J	D	M	J	D	M	J
Actinaria			1			5																		
Nemertea			1																					
Oligochaeta																								
Limnodrilus hoffmeisteri																								
Peloscolex apectinatus																								
Peloscolex gabrillae																								
Peloscolex nerthoides															3									
Peloscolex sp.												2			2			3			1			
Polychaeta																								
Capitella capitata											1													
Cossura sp.																								
Eteone lighti		1			1			2			1				10		4	3		2				1
Glycinde sp.											1	1												
Harmothoe imbricata																								
Heteromastus filiformis		4	2		2	2		3	3			1					1	1			1			1
?*Laonice* sp.																								
Mediomastus californiensis														1										
Neanthes limnicola																								
Neanthes succinea																								
Nephtys caecoides																								
Nereis sp.																								
Nerine cirratulus			1		1																			
Nerinides sp.																								
Polydora ligni						1																		
Polydora sp.																								
Pseudopolydora kempi			1		2							1			1		4						1	1
Pseudopolydora paucibranchiata																								
Pygospio elegans			1									4					27			1			3	4
Scoloplos acmeceps			1																					
Spionidae, unidentified																					1			
Streblospio benedicti		1			2			1			3			36			90			5			36	
Syllidae																								
Ostracoda																								
Copepoda																								
Isopoda																								
Gnorimosphaeroma lutea																								
Isopoda, unidentified																								
Chelifera																								
Leptochelia dubia																								
Tanais vanis																								
Amphipoda																								
Ampelisca milleri			33								1				17			29			4			22
Ampithoe lacertosa																								
Ampithoe valida																								
Corophium acherusicum																								
Corophium insidiosum			15			1									85			42			53			89
Corophium spinicorne			4												15			8						8
Corophium sp.																								
Grandidierella japonica		5	53		4			4			8			1	35		2	44			33			33
Orchestia sp.																								
Melita sp.															1									
Insecta																								
Gastropoda																								
Nassarius obsoletus																								
Bivalvia																								
Gemma gemma		43	117		65	165		55	76		55	118		12	86		22	41		11	17			65
Macoma balthica		3	6		1	7		1	6		3	5			2									2
Modiolus senhousia			1																					
Mya arenaria			7			9			6		1	19		1	4			1			2			5
Mytilus edulis																								
Tapes japonica																								
Holothuroidea																								
Fish																								

SPECIES / Sample Stations and Numbers	K15A			K15B			K15C			K15D			KS15A			KS15B			KS15C			KS15D		
	D	M	J	D	M	J	D	M	J	D	M	J	D	M	J	D	M	J	D	M	J	D	M	J
Actinaria			2									2									1			
Nemertea																					1			
Oligochaeta																								
Limnodrilus hoffmeisteri																								
Peloscolex apectinatus																								
Peloscolex gabrillae												1									1			
Peloscolex nerthoides																					1			
Peloscolex sp.															2						2			
Polychaeta																								
Capitella capitata																								
Cossura sp.																								
Eteone lighti			2			1									1			1			4			1
Glycinde sp.			1																					1
Harmothoe imbricata																								
Heteromastus filiformis			1			1			3			1			2						1			
?*Laonice* sp.																								
Mediomastus californiensis																								
Neanthes limnicola									1															
Neanthes succinea																								
Nephtys caecoides																								
Nereis sp.																								
Nerine cirratulus									1															
Nerinides sp.																								
Polydora ligni																								
Polydora sp.																								
Pseudopolydora kempi						1						4						1			1			
Pseudopolydora paucibranchiata																								
Pygospio elegans																								
Scoloplos acmeceps																								
Spionidae, unidentified																								
Streblospio benedicti															2						2			2
Syllidae																								
Ostracoda																								
Copepoda																								
Isopoda																								
Gnorimosphaeroma lutea																								
Isopoda, unidentified																								
Chelifera																								
Leptochelia dubia																								
Tanais vanis																								
Amphipoda																								
Ampelisca milleri			1												2			7			5			8
Ampithoe lacertosa																								
Ampithoe valida																								
Corophium acherusicum																								
Corophium insidiosum															39			44			81			30
Corophium spinicorne															4			1			2			
Corophium sp.																								
Grandidierella japonica															14			19			37			19
Orchestia sp.																								
Melita sp.																								
Insecta																								
Gastropoda																								
Nassarius obsoletus									1			1												
Bivalvia																								
Gemma gemma			83			313			373			345			28			56			62			65
Macoma balthica			12			11			10			14			3			3			3			1
Modiolus senhousia																								
Mya arenaria			7			14			17			9			2			1			4			5
Mytilus edulis																								
Tapes japonica																								
Holothuroidea																								
Fish																								

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SPECIES / Sample Stations and Numbers	16A			16B			16C			16D			S16A			S16B			S16C			S16D		
	D	M	J	D	M	J	D	M	J	D	M	J	D	M	J	D	M	J	D	M	J	D	M	J
Actinara																								
Nemertea																								
Oligochaeta																								
Limnodrilus hoffmeisteri			3			17			94			43			296			333			29			75
Peloscolex apectinatus																								
Peloscolex gabriellae																								
Peloscolex nerthoides																								
Peloscolex sp.																								
Polychaeta																								
Capitella capitata																								
Cossura sp.																								
Eteone lighti																								
Glycinde sp.																								
Harmothoe imbricata																								
Heteromastus filiformis																								
?Laonice sp.																								
Mediomastus californiensis																								
Neanthes limnicola																								
Neanthes succinea																								
Nephtys caecoides																								
Nereis sp.																								
Nerine cirratulus																								
Nerinides sp.																								
Polydora ligni																								
Polydora sp.																								
Pseudopolydora kempi																								
Pseudopolydora paucibranchiata																								
Pygospio elegans																								
Scoloplos acmeceps																								
Spionidae, unidentified																								
Streblospio benedicti																					5			
Syllidae																								
Ostracoda																								
Copepoda																								
Isopoda																								
Gnorimosphaeroma lutea																								
Isopoda, unidentified																								
Chelifera																								
Leptochelia dubia																								
Tanais vanis																								
Amphipoda																								
Ampelisca milleri																								
Ampithoe lacertosa																								
Ampithoe valida																								
Corophium acherusicum																								
Corophium insidiosum																					1			
Corophium spinicorne																								
Corophium sp.																								
Grandidierella japonica																								
Orchestia sp.																								
Melita sp.																								
Insecta																								
Gastropoda																								
Nassarius obsoletus																								
Bivalvia																								
Gemma gemma																								
Macoma balthica																								
Modiolus senhousia																								
Mya arenaria																								
Mytilus edulis																								
Tapes japonica																								
Holothuroidea																								
Fish																								

SPECIES / Sample Stations and Numbers	17A			17B			17C			17D			S17A			S17B			S17C			S17D		
	D	M	J	D	M	J	D	M	J	D	M	J	D	M	J	D	M	J	D	M	J	D	M	J
Actinara																								
Nemertea																								
Oligochaeta																								
Limnodrilus hoffmeisteri																								
Peloscolex apectinatus																								
Peloscolex gabriellae																								
Peloscolex nerthoides																								
Peloscolex sp.																								
Polychaeta																								
Capitella capitata		3			1			3			1			6			5			3			4	
Cossura sp.																								
Eteone lighti																								
Glycinde sp.																								
Harmothoe imbricata																								
Heteromastus filiformis																								
?Laonice sp.																								
Mediomastus californiensis																								
Neanthes limnicola																								
Neanthes succinea																								
Nephtys caecoides																								
Nereis sp.																								
Nerine cirratulus																								
Nerinides sp.																								
Polydora ligni																								
Polydora sp.																								
Pseudopolydora kempi																								
Pseudopolydora paucibranchiata																								
Pygospio elegans																								
Scoloplos acmeceps																								
Spionidae, unidentified																								
Streblospio benedicti																								
Syllidae																								
Ostracoda																								
Copepoda																								
Isopoda																								
Gnorimosphaeroma lutea																								
Isopoda, unidentified																								
Chelifera																								
Leptochelia dubia																								
Tanais vanis																								
Amphipoda																								
Ampelisca milleri																								
Ampithoe lacertosa																								
Ampithoe valida																								
Corophium acherusicum																								
Corophium insidiosum																								
Corophium spinicorne																								
Corophium sp.																								
Grandidierella japonica																								
Orchestia sp.																								
Melita sp.																								
Insecta																								
Gastropoda																								
Nassarius obsoletus																								
Bivalvia																								
Gemma gemma																								
Macoma balthica																								
Modiolus senhousia																								
Mya arenaria																								
Mytilus edulis																								
Tapes japonica																								
Holothuroidea																								
Fish																								

TOTAL INVERTEBRATES

	December	March	June
Nemertea		1	3
Actinaria		1	22
Polychaeta	842	1724	2098
Oligochaeta	510	181	1539
Ostracoda	8 *	0 *	434 *
Other Crustacea	388	456	6180 **
Mollusca	2,161	8,18	9038
Chelifera			1
Copepoda			1
Gastropoda			14
TOTAL	3909	3181	19,330

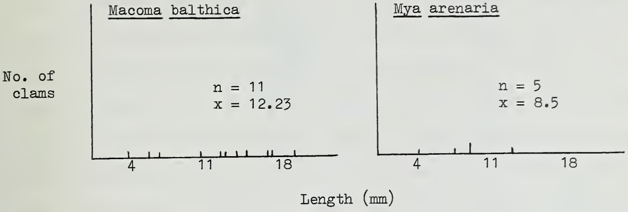
* Not all individuals of this group were sorted or counted.
** Small samples gave sufficient data for valid analysis. Large samples not included.

Comparison of Core Depth, Surface Area and Screen Size

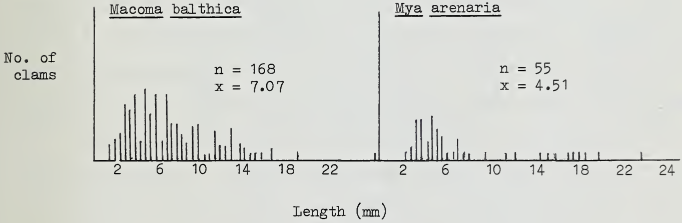
December 1972	Large Core	Small Core	Exp. Ratio	Obs. Ratio
Gemma gemma	1513	629	4.78	2.40
Macoma balthica	2	3	4.78	1.50
Mya arenaria	12	1	4.78	12.00
March 1973				
Gemma gemma	549	165	4.78	3.33
Macoma balthica	51	19	4.78	2.68
Mya arenaria	31	7	4.78	4.43
June 1973				
Gemma gemma	6583	1643	4.78	4.01
Macoma balthica	822	176	4.78	4.67
Mya arenaria	337	99	4.78	3.40

Ratio of surface of area of small versus large cores. An observed ratio smaller than the expected ratio indicates the efficiency of the smaller screen is greater than the larger screen. An observed ratio larger than the expected ratio indicates an increased efficiency of the deeper cores.

SIZE CLASS COMPARISON



MARCH

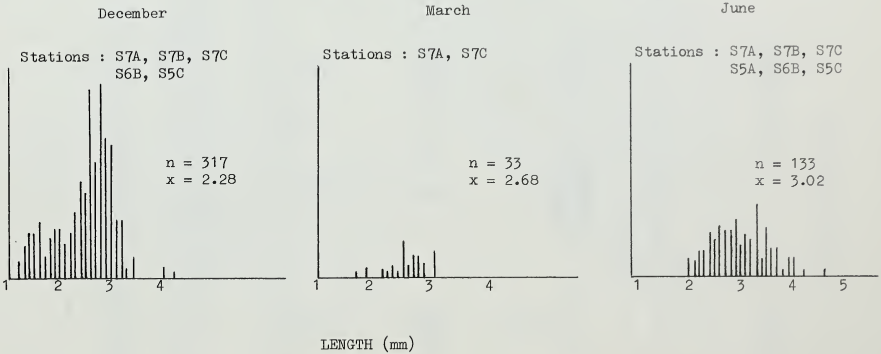


June

Macoma balthica and *Mya arenaria* size distributions collected from total small cores in March and June 1973.

SIZE CLASS COMPARISON

Gemma gemma



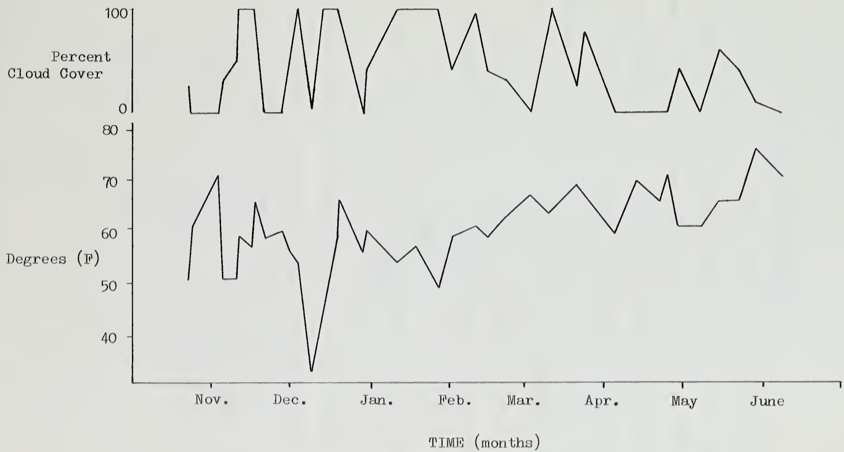
EVIDENCE FOR VERTICAL MIGRATION OF CLAMS

In December, March and June, the three major species of clams were measured and numbers plotted against length (see Tables 3 and 4). Although numbers decreased from December to March and then rose sharply, mean lengths increased steadily from December to June. The evidence was most conclusive for *Gemma gemma*, which begins its reproductive period late in June (Sellmer, 1966). When *G. gemma* were opened, those taken in March included significantly fewer ovigerous females than those taken in June. Thus, the June increases were not due to reproduction. Horizontal migration was also ruled out as a possibility, because all stations with *G. gemma*, without exception, showed an increase in numbers from March to June. Had migration been horizontal, stations would show decreases, as well as increases, in a random pattern. Evidence for migration is not as conclusive for *Mya arenaria* and *Macoma balthica* as for *Gemma gemma*, partly because their total numbers in all samplings were much smaller than those for *G. gemma*.

Vertical distribution of all three species was determined in the following manner. Numbers collected from the small cores and the large cores were compared (see Table 2). Since the large cores measure a surface area 4.78 times greater than the small cores, the expected ratio of fauna per sample is 4.78:1. Actual ratios, however, were nearly all less than 4.78:1, suggesting increased efficiency of the smaller cores, possibly caused by the finer screen used in washing. Because none of the ratios with large numbers of specimens were larger than 4.98, it is apparent that all of the specimens were in the top three inches. The ratios obtained are shown in Table 2.

As to placement of the bivalves, _Mya arenaria_ was significantly more abundant between three and six inches below the surface in December; they may have been migrating downward although their numbers were too small (14) for conclusive evidence. In March, nearly all of the specimens obtained occurred in the upper three inches of the substratum. Apparently the large bulk of the clams had vertically migrated well below the maximum sampling depth. In March and June, all of the core ratios were less than 4.78: 1 for _M. balthica_ and _Mya arenaria_, which indicates that smaller clams may have been lost through the larger mesh screens; however, comparison of numbers of clams over 10 mm long collected in March with those collected in June (see Table 4) indicates that migration was the primary cause of increase.

WEATHER GRAPH



Percent cloud cover and temperature collected on the forty bird census days from 22 October 1972 to 7 June 1973.

Multiple Range Tables

The numbers of individuals of species at each station for March and June were treated with a one-way analysis of variance test (as given in Woolf, 1968). The following tables are a multiple range analysis for each species which exhibited a significant F-value in the analysis of variance test. The F-value is given for each species along with the significance levels (0.01% or 0.05%) for the analysis of variance test and the q-value for the multiple range analysis. The q-value indicates the significant differences between stations in terms of a particular species. Each species is listed at each station from left to right in a magnitude array according to the mean number of specimens collected at each particular station. The broken line or lines beneath the station numbers indicates the stations that differ significantly in number from each other. Stations overlapped with the same line are not significantly different. Asterisk that follow q- and F-values indicate significance levels. Those values within the 95% confidence limits (i.e. 0.05%) of significance are followed by one asterisk and those highly significant values above the 99% confidence levels (i.e. 0.01%) are followed by double asterisks.

Multiple Range Analysis

<u>Limnodrilus hoffmeisteri</u>

Stations (June 1973) : 7 3K 4 4K 6 13 14 12 11 14K 15 15K 16 5 3 10 9 1

$q_{9,1} = 12.89$ ** $F^{18}_{59} = 12.70$ $F\left[\begin{matrix}12 \\ 40\end{matrix}\ 0.01\right] = 2.7$

Total Oligochaetes

Stations (June 1973) : 10 9 11 7 15K 15 13 14 3 12 5 14K 6 13K 16 4K 3K 4 1

$q_{4,1} = 14.15$ ** $F^{18}_{59} = 12.28$ ** $F\left[\begin{matrix}12 \\ 40\end{matrix}\ 0.01\right] = 2.7$

<u>Capitella capitata</u>

Stations (March 1973) : 1 3 4 6 9 10 11 13 14 16 5 7 12 15 17

$q_{15,17} = 24.23$ ** $F^{14}_{45} = 27.82$ ** $F\left[\begin{matrix}12 \\ 40\end{matrix}\ 0.01\right] = 2.7$

<u>Capitella capitata</u>

Stations (June 1973) : 1 3 3K 4 4K 5 6 9 13 13K 15 15K 12 14 7 16 14K 11

$q_{14K,11} = 4.04$ ** $F^{18}_{57} = 3.31$ ** $F\left[\begin{matrix}12 \\ 40\end{matrix}\ 0.01\right] = 2.7$

<u>Eteone lighti</u>

Stations (March 1973) : 4 16 17 1 9 10 11 3 14 12 5 6 13 7 15

$q_{11,15} = 4.52$ * $F^{14}_{45} = 2.97$ ** $F\left[\begin{matrix}12 \\ 40\end{matrix}\ 0.01\right] = 2.7$

Multiple Range Analysis

Eteone lighti

Stations (June 1973) : 1 4K 9 10 4 3K 3 14 6 13K 15K 13 15 14K 5 16 12 7 11

$q_{7,11} = 3.12$ *

$q_{10,7} = 5.13$ *

$F^{18}_{57} = 4.68$ **

$F\left[\begin{matrix}12\\40\end{matrix}\ 0.01\right] = 2.7$

Glycinde sp.

Stations (June 1973) : 1 3 3K 4 4K 5 6 7 9 10 11 13 13K 14 14K 15 15K 16 12

$q_{16,12} = 21.28$ **

$F^{18}_{57} = 24.0$ **

$F\left[\begin{matrix}12\\40\end{matrix}\ 0.01\right] = 2.7$

Heteromastus filiformis

Stations (March 1973) : 4 5 9 10 11 16 17 12 7 3 1 13 14 6 15

$q_{17,13} = 4.56$ *

$q_{12,6} = 4.56$ *

$q_{17,14} = 4.56$ *

$F^{14}_{45} = 5.01$ *

$F\left[\begin{matrix}12\\40\end{matrix}\ 0.01\right] = 2.7$

Heteromastus filiformis

Stations (June 1973) : 1 4 4K 9 10 11 5 3 12 16 7 14 15K 14K 15 3K 6 13 13K

$q_{11,14K} = 4.86$ *

$q_{5,15} = 4.86$ *

$q_{7,3K} = 4.37$ *

$q_{14,13} = 4.37$ *

$q_{15,13K} = 3.89$ *

$F^{18}_{57} = 9.59$ **

$F\left[\begin{matrix}12\\40\end{matrix}\ 0.01\right] = 2.7$

Multiple Range Analysis

Neanthes succinea

Stations (June 1973) : $\underline{1\ \ 3K\ \ 4\ \ 5\ \ 6\ \ 9\ \ 10\ \ 11\ \ 12\ \ 13\ \ 13K\ \ 14\ \ 15\ \ 15K\ \ 3\ \ 4K\ \ 14K\ \ 16}\ \ \underline{7}$

$q_{16,7} = 3.58$ * $F^{18}_{57} = 2.11$ $F\begin{bmatrix}12 & 0.05\\40 & \end{bmatrix} = 2.0$

Pseudopolydora kempi

Stations (June 1973) : $\underline{1\ \ 9\ \ 10\ \ 4\ \ 14\ \ 14K\ \ 3\ \ 3K\ \ 6\ \ 15\ \ 15K\ \ 13\ \ 14K\ \ 5\ \ 13K\ \ 16\ \ 7}\ \ \underline{12}\ \ \underline{11}$

$q_{7,12} = 6.10$ ** $F^{18}_{57} = 25.15$ ** $F\begin{bmatrix}12 & 0.01\\40 & \end{bmatrix} = 2.7$

$q_{12,\ 11} = 12.54$ **

Pygospio elegans

Stations (March 1973) : $\underline{1\ \ 3\ \ 4\ \ 5\ \ 9\ \ 10\ \ 11\ \ 12\ \ 13\ \ 14\ \ 15\ \ 16\ \ 17\ \ 6}\ \ \underline{7}$

$q_{6,7} = 16.34$ ** $F^{14}_{45} = 27.81$ ** $F\begin{bmatrix}12 & 0.01\\40 & \end{bmatrix} = 2.7$

Pygospio elegans

Stations (June 1973) : $\underline{1\ \ 3\ \ 3K\ \ 4\ \ 4K\ \ 9\ \ 10\ \ 12\ \ 15K\ \ 16\ \ 6\ \ 11\ \ 13K\ \ 15\ \ 13\ \ 5\ \ 14\ \ 14K}\ \ \underline{7}$

$q_{14K,7} = 7.04$ ** $F^{18}_{57} = 7.09$ ** $F\begin{bmatrix}12 & 0.01\\40 & \end{bmatrix} = 2.7$

Multiple Range Analysis

<u>Streblospio</u> <u>benedicti</u>

Stations (March 1973) : 9 16 17 10 11 3 14 7 1 4 5 15 12 13 6

$q_{11,4} = 4.51$ * $q_{3,12} = 4.87$ * $F^{14}_{45} = 9.72$ ** $F\begin{bmatrix}12 & 0.01\\40 & \end{bmatrix} = 2.7$

$q_{7,12} = 4.08$ * $q_{1,13} = 4.94$ *

<u>Streblospio</u> <u>benedicti</u>

Stations (June 1973) : 14 15 13K 4 4K 7 5 15K 6 10 11 3 14K 13 3K 9 1 16 12

$q_{16,12} = 7.30$ ** $F^{18}_{57} = 7.58$ * $F\begin{bmatrix}12 & 0.01\\40 & \end{bmatrix} = 2.7$

<u>Ampelisca</u> <u>milleri</u>

Stations (March 1973) : 1 3 4 6 7 9 10 12 13 14 16 17 15 5

$q_{15,5} = 11.11$ ** $F^{14}_{45} = 9.30$ * $F\begin{bmatrix}12 & 0.01\\40 & \end{bmatrix} = 2.7$

<u>Ampelisca</u> <u>milleri</u>

Stations (June 1973) : 1 9 4 4K 14 13K 3 7 13 15K 3K 14K 16 11 15 6 12 5

$q_{6,12} = 8.96$ ** $F^{18}_{57} = 19.87$ ** $F\begin{bmatrix}12 & 0.01\\40 & \end{bmatrix} = 2.7$

$q_{12,5} = 5.35$ **

Multiple Range Analysis

__Corophium insidiosum__

Stations (March 1973) : 1 3 4 5 9 10 11 15 16 17 7 12 13   6 14

$q_{13,6} = 4.20$ ** $F^{14}_{45} = 3.53$ $F\begin{bmatrix}12 & \\ 40 & 0.01\end{bmatrix} = 2.7$

__Corophium insidiosum__

Stations (June 1973) : 9 10 1 4 4K 11 16 3K 13 6 3 13K 12 15K 7 15 14 14K 5

$q_{4K,15} = 4.52$ * $q_{13,15} = 4.32$ *

$q_{16,7} = 4.74$ * $q_{14K,5} = 4.02$ *

$F^{18}_{57} = 11.07$ ** $F\begin{bmatrix}12 & \\ 40 & 0.01\end{bmatrix} = 2.7$

__Corophium__ sp.

Stations (June 1973) : 1 4 4K 5 6 9 10 11 12 15 15K 16 3 3K 13 7 13K 14   14K

$q_{14,14K} = 5.4$ ** $F^{18}_{57} = 3.76$ * $F\begin{bmatrix}12 & \\ 40 & 0.01\end{bmatrix} = 2.7$

Multiple Range Analysis

<u>Mya</u> <u>arenaria</u>

Stations (March 1973) : 1 9 10 11 12 16 17 4 15 3 6 13 5 7 14

$q_{17,5} = 4.06$ * $q_{13,14} = 4.06$ * $F^{14}_{45} = 4.64$ * $F\begin{bmatrix} 12 & 0.01 \\ 40 & \end{bmatrix} = 2.7$

$q_{4,7} = 4.06$ *

<u>Mya</u> <u>arenaria</u>

Stations (June 1973) : 1 4 9 10 11 4K 16 3 13K 13 14K 3K 7 14 6 12 15 15K 5

$q_{4K,6} = 4.73$ * $q_{7,15} = 4.34$ * $F^{18}_{57} = 10.13$ ** $F\begin{bmatrix} 12 & 0.01 \\ 40 & \end{bmatrix} = 2.7$

$q_{3K,15} = 4.47$ * $q_{15K,5} = 4.08$ **

Multiple Range Analysis

__Corophium spinicorne__

Stations (March 1973) : 1 3 4 5 7 9 10 11 12 15 16 17 14 13 6

$q_{17,14} = 5.76$ ** $F^{14}_{45} = 8.35$ ** $F\begin{bmatrix}12 & \\ 40 & 0.01\end{bmatrix} = 2.7$

__Corophium spinicorne__

Stations (June 1973) : 1 4 4K 7 9 10 13 13K 14K 3 14 3K 12 16 15K 6 11 15 5

$q_{15k,11} = 3.60$ *

$q_{6,15} = 4.01$ *

$F^{18}_{40} = 6.04$ * $F\begin{bmatrix}12 & \\ 40 & 0.01\end{bmatrix} = 2.7$

__Grandidierella japonica__

Stations (March 1973) : 4 9 10 11 16 17 3 7 5 13 1 15 6 14 12

$q_{14,12} = 16.02$ ** $F^{14}_{45} = 26.84$ ** $F\begin{bmatrix}12 & \\ 40 & 0.01\end{bmatrix} = 2.7$

__Grandidierella japonica__

Stations (June 1973) : 1 4 4K 9 10 11 12 5 15K 13 14K 3 3K 6 15 16 14 13K 7

$q_{10,5} = 4.01$ * $q_{14K,16} = 4.20$ *

$q_{11,3} = 4.77$ * $q_{15,7} = 4.10$ *

$q_{12,15} = 4.31$ *

$F\begin{bmatrix}12 & \\ 40 & 0.01\end{bmatrix} = 2.7$

Multiple Range Analysis

Gemma gemma

Stations (March 1973) : 1 4 9 10 11 16 17 5 3 13 6 7 14 12 15

$q_{17,7} = 5.28$ ** $q_{14,12} = 2.95$ * $F^{14}_{45} = 20.88$ ** $F\left[\begin{matrix}12\\40\end{matrix}\ 0.01\right] = 2.7$

$q_{5,14} = 4.09$ * $q_{12,15} = 8.18$ *

Gemma gemma

Stations (June 1973) : 1 4 4K 9 10 11 16 3K 6 3 14K 14 13 7 13K 15 5 15K 12

$q_{15,5} = 3.31$ * $F^{18}_{57} = 16.62$ ** $F\left[\begin{matrix}12\\40\end{matrix}\ 0.01\right] = 2.7$

$q_{15K,12} = 6.24$ **

Macoma balthica

Stations (March 1973) : 4 5 9 10 11 16 17 1 12 13 6 15 3 7 14

$q_{15,7} = 3.62$ * $F^{14}_{45} = 6.94$ ** $F\left[\begin{matrix}12\\40\end{matrix}\ 0.01\right] = 2.7$

Macoma balthica

Stations (June 1973) : 1 9 10 5 4 4K 11 12 15 7 14 14K 15K 3 13 6 16 3K 13K

$q_{4,14} = 4.58$ * $q_{7,13} = 4.21$ *

$q_{4,15} = 4.67$ * $q_{13,3K} = 3.75$ * $F^{18}_{57} = 25.36$ ** $F\left[\begin{matrix}12\\40\end{matrix}\ 0.01\right] = 2.7$

$q_{15,3} = 4.30$ * $q_{3K,13K} = 5.40$ **

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Appendix D-4

SPECIES LIST OF
FISHES IN CORTE MADERA CREEK

FISHES COLLECTED IN CORTE MADERA CREEK BY MACKEY AND KIRSCHBAUM *
1959 - 1964

The portion of the stream where collections were made is that portion from 2.8 miles above the mouth of the estuary (between Greenbrae and Kentfield) to 4.3 miles above the mouth (at Ross). In other words, collections were made in brackish as well as freshwater parts of the stream.

Primary Freshwater Fishes	Scientific Name
Carp (introduced species)	Cyprinus carpio
California Roach	Hesperoleucas symmetricus
Sacramento Squawfish	Ptychocheilus grandis
Sacramento Sucker	Catostomus occidentalis
Green Sunfish (introduced)	Lepomis cyanellus
Black Crappie (stocked)	Pomoxis nigromaculatus
Tule Perch	Hysterocarpus traski

Secondary Freshwater, Brackish Water, Marine and Diadromous Fishes	
Leopard Shark	Triakis semifasciata
Pacific Herring	Clupea harengus
Threadfin Shad	Dorosoma petenense
Northern Anchovy	Engraulis mordax
Rainbow Trout	Salmo gairdneri
Rainwater Killifish	Lucania parva
Mosquitofish (introduced)	Gambusia affinis
Threespined Stickleback	Gasterosteus aculeatus
Bay Pipefish	Syngnathus californiensis
Striped Bass (introduced)	Roccus saxatilis
Shiner Perch	Cymatogaster aggregata
Arrow Goby	Clevelandia ios
Tidewater Goby	Eucyclogobius newberryi
Longjaw Mudsucker	Gillichthys mirabilis
Staghorn Sculpin	Leptocottus armatus
Topsmelt	Atherinops affinis
Starry Flounder	Platichthys stellatus

FISHES IN CORTE MADERA CREEK
(Reported in Interviews with Fishermen, April - May, 1973.)

Common Name	Other names	Season	Scientific Name
Perch	Rubber Lips	Nov-Mar	Rhacochilus toxotes
	Silver Perch	Early Spr.	Hyperprosopon ellipticum
	Pier Perch	All year	Rhacochilus vacca
Staghorn Sculpin	Bull Head	All year	Leptocottus armatus
Starry Flounder		All year	Platichthys stellatus
Striped Bass	Bass, Stripes	Apr-Oct	Roccus saxatilis
Leopard Sharks	Sharks	All year	Triakis semifasciata
Stickleback		All year	Gasterosteus aculeatus
Bat Rays	Suidheads Sting Rays	All year	Myliobatis californicus
Silversides, Smelt	Jacksmelt	Apr-Oct	Antheriops Californiensis
	Topsmelt		Antheriops affinis
Anchovie		Dec-Feb	Engraulis mordax
Herring		Dec-Feb	Clupea harengus

Appendix D-5

BIRDS USING LARKSPUR FERRY TERMINAL
PROJECT AREA

Birds Sighted on Larkspur Ferry Terminal Project Area
October 22, 1972 - June 1, 1973

Common Name	Scientific Name
Water, Marsh, and Shorebirds	
Eared Grebe	Podiceps caspicus
Western Grebe	Aechmophorus occidentalis
Pied-billed Grebe	Podilymbus podiceps
Great Blue Heron	Ardea herodias
Common Egret	Casmerodias alba
Snowy Egret	Leucophoyx thula
Mallard	Anas platyrhynchos
Pintail	Anas acuta
Cinnamon Teal	Anas cyanoptera
Canvasback	Aythya valisineria
Scaup, Greater	Aythya marila
Scaup, Lesser	Aythya affinis
Bufflehead	Bucephala albeola
Ruddy Duck	Oxyura jamaicensis
Clapper Rail	Rallus longirostris
American Coot	Fulica americana
Killdeer	Charadrius vociferus
Ruddy Turnstone	Arenaria interpres
Black-bellied Plover	Squatarola squatarola
Common Snipe	Capella gallinago
Long-billed Curlew	Numenius americanus
Whimbrel	Numenius phaeopus
Spotted Sandpiper	Actits macularia
Willet	Catoptrophorus semipalmatus
Yellow Legs	Totanus sp.
Least Sandpiper	Erolia minutilla
Dunlin	Erolia alpina
Dowitcher	Limnodromus
Western Sandpiper	Ereunetes mauri
Marbled Godwit	Limosa fedoa
American Avocet	Recurvirostra americana
Western Gull	Larus occidentalis
Herring Gull	Larus argentatus
California Gull	Larus californicus
Ring-billed Gull	Larus delawarensis
Arctic Tern	Sterna paradisaea
Forster's Tern	Sterna fosteri
Caspian Tern	Hydroprogne caspia
Belted Kingfisher	Megaceryle alcyon

Common Name	Scientific Name
Water, Marsh, and Shorebirds (continued)	
Common Loon	Gavia immer
Red-throated Loon	Gavia stellata
Cormorant	Phalacrocornx
Red-breasted Merganser	Mergus serrator
Land birds	
Sparrow Hawk	Falco sparverius
Mourning Dove	Zenaidura macroura
Savannah Sparrow	Passerculus sandwichensis
White-crowned Sparrow	Zonotrichia leucophrys
Golden-crowned Sparrow	Zonotrichia atricapilla
Song Sparrow	Melospiza melodia

BIRDS SIGHTED ON LARKSPUR FERRY TERMINAL PROJECT

AREA A -- ISLAND NORTH

OCTOBER 22, 1972 - JUNE 7, 1973

1972

Date	Oct 22	Oct 23	Nov 2	Nov 4	Nov 9	Nov 10	Nov 15	Nov 16	Nov 20	Nov 27	Nov 30	Dec 3	Dec 8	Dec 12	Dec 18	Dec 19	Dec 28	Dec 29
Time	6:00P	4:30P	2:15P	4:00P	6:45A	7:05A	12:45P	1:20P	3:15P	10:10A	1:10P	3:00P	7:00A	8:40A	2:00P	2:30P	11:30A	12 N
Corr. low tide	7:12P	7:59P	4:27P	5:37P	7:18A	8:01A	1:51P	2:44P	6:01P	12:18P	3:36P	5:25P	7:01A	11:07A	5:01P	5:49P	2:06P	3:01P
Temp.	50°	60°	70°	50°	50°	58°	56°	65°	58°	59°	55°	53°	32°	44°	58°	65°	55°	59°
Wind vel.	0-5	0	0-5	10-20	0	0-5	10-25	0-5	0	0-5	10	10	0-5	5-10	5	0-5	15	3-10
Cloud cover	25%	0%	0%	30%	50%	100%	100%	100%	0%	0%	40%	100%	5%	100%	100%	90%	0%	40%
Avocet					1		16	1		2	1		2	3	1	1	2	3
Coot	35	12	4	4	4	17	30	49	26		8					2	54	23
Cormorant										3	5	2			1			
Curlew, Long B.										1				1				
Dowitcher	1			42					3		1	2		3	6	6	1	
Duck, U.I.																		
Bufflehead						2												
Canvasback							5											
Cinnamon Teal																		
Domestic/Hybrid																		
Mallard																		
Merganser, R.B.																		
Pintail																		
Ruddy													6				9	2
Scaup																		
Egret, Common		1																
Snowy																		
Godwit, Marbled	1	1	2	1				2	2	3	2			1	2		1	1
Grebe, U.I.																		
Eared																		
Pied B.																		
Western			1			1												
Gull, U.I.												1						7
Calif.																		
Herring																		
Ring B.																		
Western																		
Heron, G.B.																		
Kingfisher																		
Loon, Common																		
R.T.																		
Peeps, U.I.	225			63											87			
Dunlin		1	79		101	94	11	93	200	111	206	116	153	171	52	69	124	73
Least Sandpiper													87	118	71	9	150	150
Spotted "																		
Western "		141	80			41		89	86	88	48	17	111	123	63	128	206	202
Plover, Black-bellied	5			1				1	2	2	1	1		1	2	2		1
Killdeer	10		4	2							2			1	1	1		3
Rail, Clapper																		
Snipe, Common																		
Tern, Arctic																		
Caspian																		
Forster's																		
Turnstone, R.																		
Yellowlegs									2		1						1	
Whimbrel								1										
Willet	5	1	3	5	1	1					1		1	1	1	2		1

BIRDS SIGHTED ON LARKSPUR FERRY TERM... PROJECT

AREA A - ISLAND NORTH

OCTOBER 22, 1972 - JUNE 7, 1973

	1973 Jan 10	Jan 17	Jan 24	Jan 31	Feb 9	Feb 14	Feb 21	Mar 2	Mar 10	Mar 16	Mar 26	Mar 29	Apr 4	Apr 12	Apr 21	Apr 24	Apr 28	May 7	May 14	May 21	May 28	Jun 7
Time	9:15A	2:00P	8:30A	2:30P	1030A	3:00P	8:15A	3:35P	8:00A	2:15P	1230P	1240P	4:00P	2:15P	6:30A	8:30A	11:45A	9:00A	3:10P	7:45A	3:15P	8:45A
Corr. low tide	1035A	5:39P	1100A	5:12P	1117A	4:35P	9:14A	5:05P	1053A	4:49P	1228P	3:01P	6:39P	2:45P	8:58A	1128A	2:43P	1116A	5:12P	1011A	3:37P	6:11A
Temp.	53°	56°	48°	58°	60°	58°	62°	66°	62°	63°	68°	67°	66°	69°	65°	70°	60°	60°	65°	65°	75°	70°
Wind vel.	0-5	10-30	0-5	0-5	0-10	0-5	0	5-10	0-5	5-15	5-10	5-10	5-10	10	5-15	0-5	15-25	5-10	5-15	5-15	0-5	0-5
Cloud cover	100%	100%	100%	40%	95%	40%	30%	0%	100%	80%	25%	60%	0%	0%	0%	0%	40%	0%	60%	40%	10%	0%
Avocet	1	2	2								2	2	1		2							
Coot	46	70	73	12	16	26	11	57	43	17	28	47	3	19	15	3	2		1		1	
Cormorant		2					2															
Curlew, Long B.													1									
Dowitcher																	1					
Duck, U.I.																						
Bufflehead	7		2		1																	
Canvasback	5		1																			
Cinnamon Teal																						
Domestic/Hybrid																						
Mallard																						
Merganser, R.B.																						
Pintail																						
Ruddy	3	1		1		3																
Scaup		2																				
Egret, Common																				1		
Snowy															2							
Godwit, Marbled	1	1	1	1	1	2			3						1							
Grebe, U.I.																						
Eared																						
Pied B.																						
Western		1																				
Gull, U.I.		1	11	2							1											
Calif.																						
Herring																						
Ring B.																						
Western																						
Heron, G.B.																						
Kingfisher																						
Loon, Common																						
R.T.																						
Peeps, U.I.	112																					
Dunlin			1	9																		
Least Sandpiper																						
Spotted "																						
Western "		45	90	106									7		63	1300	263					
Plover, Black-bellied			2	3				2														
Killdeer			4	6		2															1	
Rail, Clapper																						
Snipe, Common																						
Tern, Arctic																						
Caspian																						
Forster's																						
Turnstone, R.																						
Yellowlegs																						
Whimbrel									1		1						2					
Willet	1	1	1	1	1	3	1					1			1							

BIRDS SIGHTED ON LARKSPUR FERRY TERMINAL PROJECT

AREA B - NORTH CHANNEL

OCTOBER 22, 1972 - JUNE 7, 1973

1972

Date	Oct 22	Oct 23	Nov 2	Nov 4	Nov 9	Nov 10	Nov 15	Nov 16	Nov 20	Nov 27	Nov 30	Dec 3	Dec 8	Dec 12	Dec 18	Dec 19	Dec 28	Dec 29
Time	6:15P	4:45P	3:00P	4:25P	7:05A	7:55A	2:05P	1:40P	4:05P	1025A	1:25P	3:15P	7:25A	9:10A	2:40P	2:45P	1230P	1250P
Corr. low tide	7:12P	7:59P	4:27P	5:37P	7:18A	8:01A	1:51P	2:44P	6:01P	1218P	3:36P	5:25P	7:01A	1107A	5:01P	5:49P	2:06P	3:01P
Temp.	50°	60°	70°	50°	50°	58°	56°	65°	58°	59°	55°	53°	32°	44°	56°	65°	55°	59°
Wind vel.	0-5	0	0-5	10-20	0	0-5	10-25	0-5	0	0-5	10	10	0-5	5-10	5	0-5	15	3-10
Cloud cover	25%	0%	0%	30%	50%	100%	100%	100%	0%	0%	40%	100%	5%	100%	100%	90%	0%	40%
Avocet	12	13	9	28	46	21	18	28	13	50	9	17	29	50	31	12	6	10
Coot	3							7	15	107	112	26		18		40		2
Cormorant																		
Curlew, Long B.															1			
Dowitcher				2				1		2	3	1	5	14	11	5		
Duck, U.I.																		
Bufflehead											4	4	2	3	11	24	2	
Canvasback							5											
Cinnamon Teal																		
Domestic/Hybrid																		
Mallard														2				
Merganser, R.B.																		
Pintail					5												6	
Ruddy							8	2		3	12	7		18	64	17	56	4
Scaup			5			6	11	5	3		2	6	4	5	5	4		
Egret, Common		2																
Snowy																		
Godwit, Marbled				1											1			
Grebe, U.I.																		
Eared																		
Pied B.																		
Western		1				3	1	1			2							
Gull, U.I.										1	4	10						
Calif.																		
Herring																		
Ring B.								24										
Western																		
Heron, G.B.																		
Kingfisher									1									
Loon, Common																		
R.T.																		
Peeps, U.I.				2		55						26						
Dunlin			16		246		18	16		471	44	3	109	113		100	3	
Least Sandpiper		178											74	117		14	1	
Spotted "												2						
Western "			25		55		1	44		426	143	23	110	234		50	8	
Plover, Black-bellied					2			2		2	2	1	2	1	1	1		1
Killdeer		3		7				2	5	2	4		1	4	3	4	1	1
Rail, Clapper																		
Snipe, Common																		
Tern, Arctic																		
Caspian																		
Forster's																		
Turnstone, R.											1							
Yellowlegs	1	1																
Whimbrel																		
Willet	3	1	1	2	4	2		2	1	3		1	3	54	2	3	1	

BIRDS SIGHTED ON LARKSPUR FERRY T[illegible] PROJECT

AREA B - NORTH CHANNEL

OCTOBER 22, 1972 - JUNE 7, 1973

1973

Date	Jan 10	Jan 17	Jan 24	Jan 31	Feb 9	Feb 14	Feb 21	Mar 2	Mar 10	Mar 16	Mar 26	Mar 29	Apr 4	Apr 12	Apr 21	Apr 24	Apr 28	May 7	May 14	May 21	May 28	Jun 7
Time	8:00A	2:25P	8:55A	2:50P	1040A	3:20P	8:30A	3:45P	8:20A	2:35P	1245P	1:30P	4:30P	2:20P	7:45A	8:40A	1150A	9:15A	3:20P	7:20A	3:00P	9:00A
Corr. low tide	1035A	5:39P	1100A	5:12P	1117A	4:35P	9:14A	5:05P	1053A	4:49P	1226P	3:01P	5:39P	2:45P	8:58A	1128A	2:43P	1116A	5:12P	1011A	3:37P	6:11A
Temp.	53°	56°	48°	58°	60°	58°	62°	66°	62°	63°	68°	55°	66°	69°	65°	70°	60°	60°	65°	65°	75°	70°
Wind vel.	0-5	10-30	0-5	0-5	0-10	0-5	0	5-10	0-5	5-15	5-10	15-25	5-10	10	5-15	0-5	15-25	5-10	5-15	5-15	0-5	0-5
Cloud cover	100%	100%	100%	40%	95%	40%	30%	0%	100%	80%	25%	80%	0%	0%	0%	0%	40%	0%	60%	40%	10%	0%
Avocet	18	10	5	5		2																
Coot	1	4		5	64	21	15		4	1	11											
Cormorant																						
Curlew, Long B.																						
Dowitcher																						
Duck, U.I.																						
Bufflehead	3	13	4	2		2																
Canvasback	1																					
Cinnamon Teal																						
Domestic/Hybrid																						
Mallard									2	2												
Merganser, R.B.																						
Pintail																						
Ruddy	23	11	18	6	1	2																
Scaup			1			2																
Egret, Common																						
Snowy																						
Godwit, Marbled								1														
Grebe, U.I.																						
Eared									1													
Pied B.																						
Western																						
Gull, U.I.					14						1											
Calif.																						
Herring																						
Ring B.																						
Western																						
Heron, G.B.																						
Kingfisher																						
Loon, Common																						
R.T.																						
Peeps, U.I.				2																		
Dunlin	19	6														2						
Least Sandpiper	17	6																				
Spotted "																						
Western "	54	160	14													379	1240					
Plover, Black-bellied			1																			
Killdeer		2	1	2	4		3	6		1	5								1			
Rail, Clapper																						
Snipe, Common																						
Tern, Arctic																						
Caspian																						
Forster's																						
Turnstone, R.																						
Yellowlegs	1		1				1						1									
Whimbrel								1			1											
Willet	2	2	4	3	3		2	1	2		1											

BIRDS SIGHTED ON LARKSPUR FERRY TERMINAL PROJECT

AREA C - ISLAND SOUTH

OCTOBER 22, 1972 - JUNE 7, 1973

1972

Date	Oct 22	Oct 23	Nov 2	Nov 4	Nov 9	Nov 10	Nov 15	Nov 16	Nov 20	Nov 27	Nov 30	Dec 3	Dec 8	Dec 12	Dec 18	Dec 19	Dec 28	Dec 29
Time	6:20P	5:05P	3:20P	4:40P	7:15A	8:10A	1:55P	2:00P	4:25P	1055A	1:50P	3:25P	7:45A	1000A	3:10P	3:10P	1240P	1:15P
Corr. low tide	7:12P	7:59P	4:27P	5:37P	7:18A	8:01A	1:51P	2:44P	6:01P	1218P	3:36P	5:25P	7:01A	1107A	5:01P	5:49P	2:06P	5:01P
Temp.	50°	60°	70°	50°	50°	58°	56°	65°	58°	59°	55°	53°	32°	44°	58°	65°	55°	59°
Wind vel.	0-5	0	0-5	10-20	0	0-5	10-25	0-5	0	0-5	10	10	0-5	5-10	5	0-5	15	3-10
Cloud cover	25%	0%	0%	30%	50%	100%	100%	100%	0%	0%	40%	100%	5%	100%	100%	90%	0%	40%
Avocet		2	3	2	1	22	12				2	2	28		1			1
Coot	5	4	6		3	9	6		56		13	89	22	8	31	43		24
Cormorant											1	1					4	1
Curlew, Long B.										2	2				1			
Dowitcher						9			4		2	2			11			2
Duck, U.I.																		
Bufflehead																		
Canvasback																		
Cinnamon Teal																		
Domestic/Hybrid																		
Mallard																		
Merganser, R.B.																		
Pintail																		
Ruddy	3	1																
Scaup																		
Egret, Common				1														
Snowy																		
Godwit, Marbled		2		1	1						1	1			1		2	2
Grebe, U.I.																		
Eared																		
Pied B.																		
Western	2		1	1														
Gull, U.I.		3			40	6	4				32					2	230	47
Calif.											91							
Herring																		
Ring B.		18	6		107					84			410	220				
Western		9																
Heron, G.B.																		
Kingfisher																		
Loon, Common																		
R.T.																		
Peeps, U.I.	100						82											
Dunlin					475	244		34	1	83	23	7	148	69		26		1
Least Sandpiper			2										56	132		42		
Spotted "				2														
Western "					4	105		140		224	18		30	51			80	
Plover, Black-bellied													4	1	1		1	
Killdeer		5	4	3					3		5						5	1
Rail, Clapper																		
Snipe, Common																		
Tern, Arctic																		
Caspian																		
Forster's		7																
Turnstone, R.																		
Yellowlegs																		
Whimbrel																		
Willet		4	1	1	17	22			2				75	2	2			3

BIRDS SIGHTED ON LARKSPUR FERRY T[illegible] PROJECT

AREA C - ISLAND SOUTH

OCTOBER 22, 1972 - JUNE 7, 1973

1973

Date	Jan 10	Jan 17	Jan 24	Jan 31	Feb 9	Feb 14	Feb 21	Mar 2	Mar 10	Mar 16	Mar 26	Mar 29	Apr 4	Apr 12	Apr 21	Apr 24	Apr 28	May 7	May 14	May 21	May 28	Jun 7
Time	8:35A	2:45P	9:20A	3:15P	1055A	3:40P	8:50A	3:55P	8:35A	2:50P	1:00P	2:00P	4:20P	2:25P	7:00A	8:45A	1230P	[illegible]:30A	3:25P	7:00A	2:45P	8:45A
Corr. low tide	1035A	5:39P	1100A	5:12P	1117A	4:35P	9:14A	5:05P	1053A	4:49P	1228P	3:01P	6:39P	2:45P	8:58A	1128A	2:43P	1116A	5:12P	1011A	3:37P	6:11A
Temp.	53°	56°	48°	58°	60°	58°	62°	66°	62°	63°	68°	67°	66°	69°	65°	70°	60°	60°	65°	65°	75°	70°
Wind vel.	0-5	10-30	0-5	0-5	0-10	0-5	0	5-10	0-5	5-15	5-10	5-10	5-10	10	5-15	0-5	15-25	5-10	5-15	5-15	0-5	0-5
Cloud cover	100%	100%	100%	40%	95%	40%	30%	0%	100%	80%	25%	80%	0%	0%	0%	0%	40%	0%	60%	40%	10%	0%
Avocet	10		6	3	4						3	4	2		2							
Coot	5	42	18	74	80	45	33	6	32		11	7			20			1				
Cormorant						1			1													
Curlew, Long B.																						
Dowitcher															2							
Duck, U.I.																						
Bufflehead		6																				
Canvasback																						
Cinnamon Teal																						
Domestic/Hybrid																	2					
Mallard																	1					
Merganser, R.B.																						
Pintail																						
Ruddy																						
Scaup																						
Egret, Common																						1
Snowy																						
Godwit, Marbled	1			2	1	1			1	2			7									
Grebe, U.I.																						
Eared															5							
Piel B.																						
Western																						
Gull, U.I.	29	54	86	12			165	1	140	22	112	45							1			
Calif.																						
Herring															4							
Ring B.																						
Western																						
Heron, G.B.		1																				
Kingfisher																						
Loon, Common																						
R.T.																						
Peeps, U.I.													25									
Dunlin	4	70	13	1		1																
Least Sandpiper	18	14		1																		
Spotted "																						
Western "	111	164	232	3											30	485	220					
Plover, Black-bellied		1		2	2	2					2	1			2							
Killdeer		1	6	9	3	4	1															
Rail, Clapper																						
Snipe, Common						2																
Tern, Arctic																						
Caspian																						
Forster's																						
Turnstone, R.																						
Yellowlegs																						
Whimbrel											2											
Willet	1		1	2	3	3	2		2													

BIRDS SIGHTED ON LARKSPUR FERRY TERMINAL PROJECT

AREA D - POND AND DITCH

OCTOBER 22, 1972 - JUNE 7, 1973

1972

Date	Oct 22	Oct 23	Nov 2	Nov 4	Nov 9	Nov 10	Nov 15	Nov 16	Nov 20	Nov 27	Nov 30	Dec 3	Dec 8	Dec 12	Dec 18	Dec 19	Dec 28	Dec 29
Time	6:30P	5:20P	3:45P	4:55P	7:40A	8:50A	1:20P	2:50P	5:00P	1120A	2:10P	3:45P	8:05A	1015A	3:30P	3:25P	1250P	1205P
Corr. low tide	7:12P	7:59P	4:27P	5:37P	7:18A	8:01A	1:51P	2:44P	6:01P	1218P	3:36P	5:25P	7:01A	1107A	5:01P	5:49P	2:06P	3:01P
Temp.	50°	60°	70°	50°	50°	58°	56°	65°	58°	59°	55°	53°	32°	44°	58°	65°	55°	59°
Wind vel.	0-5	0	0-5	10-20	0	0-5	10-25	0-5	0	0-5	10	10	0-5	5-10	5	0-5	15	3-10
Cloud cover	25%	0%	0%	30%	50%	100%	100%	100%	0%	0%	40%	100%	5%	100%	100%	90%	0%	40%
Avocet		2		2	3	4	8	3		1		3		1				4
Coot							13											
Cormorant																		
Curlew, Long B.																		
Dowitcher						6												
Duck, U.I.																		
Bufflehead																		
Canvasback							2											
Cinnamon Teal																		
Domestic/Hybrid																		
Mallard							6											
Merganser, R.B.																		
Pintail																		
Ruddy																		
Scaup																		
Egret, Common													2					
Snowy													1					
Godwit, Marbled																		
Grebe, U.I.																		
Eared																		
Pied B.																		
Western							2					1						
Gull, U.I.				1			1					13						5
Calif.																		
Herring																		
Ring B.										48								
Western																		
Heron, G.B.													1	1				
Kingfisher																		
Loon, Common																		
R.T.																		
Peeps, U.I.																		
Dunlin						1												
Least Sandpiper																		
Spotted "																		
Western "																		
Plover, Black-bellied																		
Killdeer		4		4	15		1		1	3	6		4	1				9
Rail, Clapper																		
Snipe, Common		1								1								
Tern, Arctic																		
Caspian																		
Forster's																		
Turnstone, R.																		
Yellowlegs										1								
Whimbrel																		
Willet					1								1	1				

BIRDS SIGHTED ON LARKSPUR FERRY T[illegible] PROJECT

AREA D - POND AND DITCH

OCTOBER 22, 1972 - JUNE 7, 1973

	1973 Jan 10	Jan 17	Jan 24	Jan 31	Feb 9	Feb 14	Feb 21	Mar 2	Mar 10	Mar 16	Mar 26	Mar 29	Apr 4	Apr 12	Apr 21	Apr 24	Apr 28	May 7	May 14	May 21	May 28	Jun 7
Date	Jan 10	Jan 17	Jan 24	Jan 31	Feb 9	Feb 14	Feb 21	Mar 2	Mar 10	Mar 16	Mar 26	Mar 29	Apr 4	Apr 12	Apr 21	Apr 24	Apr 28	May 7	May 14	May 21	May 28	Jun 7
Time	9:10A	3:25P	9:50A	3:40P	1125A	3:50P	9:30A	4:00P	8:50A	3:10P	1:35P	2:30P	4:50P	2:45P	8:00A	9:15A	1250P	9:30A	3:45P	8:10A	3:20P	9:05A
Corr. low tide	1035A	5:39P	1100A	5:12P	1117A	4:35P	9:14A	5:05P	1053A	4:49P	1228P	3:01P	6:39P	2:45P	8:58A	1128A	2:43P	1116A	5:12P	1011A	3:37P	6:11A
Temp.	53°	56°	48°	58°	60°	58°	62°	66°	62°	63°	68°	67°	66°	69°	65°	70°	60°	60°	65°	65°	75°	70°
Wind vel.	0-5	10-30	0-5	0-5	0-10	0-5	0	5-10	0-5	5-15	5-10	5-10	5-10	10	5-15	0-5	15-25	5-10	5-15	5-15	0-5	0-5
Cloud cover	100%	100%	100%	40%	95%	40%	30%	0%	100%	80%	25%	80%	0%	0%	0%	0%	40%	0%	60%	40%	10%	0%
Avocet	2	3		1																		
Coot																						
Cormorant																						
Curlew, Long B.																						
Dowitcher																						
Duck, U.I.																						
Bufflehead																						
Canvasback																						
Cinnamon Teal																						
Domestic/Hybrid																						
Mallard																					2	
Merganser, R.B.																						
Pintail																						
Ruddy																						
Scaup																						
Egret, Common				1																		
Snowy																						
Godwit, Marbled																						
Grebe, U.I.																						
Eared																						
Pied B.																						
Western																						
Gull, U.I.	2																					
Calif.																						
Herring																						
Ring B.																						
Western																						
Heron, G.B.																						
Kingfisher																						
Loon, Common																						
R.T.																						
Peeps, U.I.																						
Dunlin																						
Least Sandpiper																						
Spotted "																						
Western "																						
Plover, Black-bellied																						
Killdeer		1	2	3	2				3		1											
Rail, Clapper																						
Snipe, Common																						
Tern, Arctic																						
Caspian																						
Forster's																						
Turnstone, R.																						
Yellowlegs		1																				
Whimbrel																						
Willet				2																		

BIRDS SIGHTED ON LARKSPUR FERRY TERMINAL PROJECT

AREA E - CORTE MADERA CREEK

OCTOBER 22, 1972 - JUNE 7, 1973

1972

Date	Oct 22	Oct 23	Nov 2	Nov 4	Nov 9	Nov 10	Nov 15	Nov 16	Nov 20	Nov 27	Nov 30	Dec 3	Dec 8	Dec 12	Dec 18	Dec 19	Dec 28	Dec 29
Time	6:25P	5:30P	3:30P	4:48P	7:45A	8:40A	1:35P	2:40P	4:40P	1020A	2:20P	3:35P	8:00A	1020A	3:20P	3:15P	1245P	1205P
Corr. low tide	7:12P	7:59P	4:27P	5:37P	7:18A	8:01A	1:51P	2:44P	6:01P	1218P	3:36P	5:25P	7:01A	1107A	5:01P	5:49P	2:06P	3:01P
Temp.	50°	60°	70°	50°	50°	58°	56°	65°	58°	59°	55°	53°	32°	44°	58°	65°	55°	59°
Wind vel.	0-5	0	0-5	10-20	0	0-5	10-25	0-5	0	0-5	10	10	0-5	5-10	5	0-5	15	3-10
Cloud cover	25%	0%	0%	30%	50%	100%	100%	100%	0%	0%	40%	100%	5%	100%	100%	90%	0%	40%
Avocet															1		1	
Coot								7					3	4	28	14		3
Cormorant																	5	5
Curlew, Long B.																		
Dowitcher									14		2							
Duck, U.I.																		
Bufflehead														7	3			
Canvasback							70						35	106	1	2		
Cinnamon Teal																		
Domestic/Hybrid	4			9							8							
Mallard	3								6				2	9	3			
Merganser, R.B.																		
Pintail											8							
Ruddy								1					2	14	6	10	1	2
Scaup						2		12					2	4	11	16		4
Egret, Common		1		1	1				1									
Snowy				1														
Godwit, Marbled																		
Grebe, U.I.																		
Eared																		
Pied B.																		
Western	3									1				1				
Gull, U.I.																		
Calif.																		
Herring																		
Ring B.																		
Western																		
Heron, G.B.																		
Kingfisher																		
Loon, Common																		
R.T.																		
Peeps, U.I.	80							88										
Dunlin									1		9							
Least Sandpiper																		
Spotted "																		
Western "											6							
Plover, Black-bellied																		
Killdeer									5	2								
Rail, Clapper						1												
Snipe, Common																		
Tern, Arctic																		
Caspian																		
Forster's																		
Turnstone, R.																		
Yellowlegs																		
Whimbrel																		
Willet					4						1			2		1		2

BIRDS SIGHTED ON LARKSPUR FERRY TERM PROJECT

AREA E - CORTE MADERA CREEK

OCTOBER 22, 1972 - JUNE 7, 1973

1973	Jan 10	Jan 17	Jan 24	Jan 31	Feb 9	Feb 14	Feb 21	Mar 2	Mar 10	Mar 16	Mar 26	Mar 29	Apr 4	Apr 12	Apr 21	Apr 24	Apr 28	May 7	May 14	May 21	May 28	Jun 7
Date	Jan 10	Jan 17	Jan 24	Jan 31	Feb 9	Feb 14	Feb 21	Mar 2	Mar 10	Mar 16	Mar 26	Mar 29	Apr 4	Apr 12	Apr 21	Apr 24	Apr 28	May 7	May 14	May 21	May 28	Jun 7
Time	8:50A	3:05P	9:25A	3:30P	1105A	4:00P	9:10A	4:00P	9:02A	3:07P	1:15P	2:15P	4:35P	2:35P	7:30A	8:50A	1240P	8:40A	3:30P	8:00A	3:15P	9:05A
Corr. low tide	1035A	5:39P	1100A	5:12P	1117A	4:35P	9:14A	5:05P	1053A	4:49P	1228P	3:01P	6:39P	2:45P	8:58A	1128A	2:43P	1116A	5:12P	1011A	3:37P	5:11A
Temp.	53°	56°	48°	58°	60°	58°	62°	56°	62°	63°	68°	67°	66°	69°	65°	70°	60°	60°	65°	65°	75°	70°
Wind vel.	0-5	10-30	0-5	0-5	10-20	5-10	0	5-10	0-5	5-15	5-10	15-25	5-10	10	5-15	0-5	15-25	5-10	10-25	5-15	0-5	0-5
Cloud cover	100%	100%	100%	40%	95%	40%	30%	0%	100%	80%	25%	80%	0%	0%	0%	0%	40%	0%	60%	40%	10%	0%
Avocet		1						1			1											
Coot	16	15	24	9	22	2					5	5		9	5			1				
Cormorant		1	1																			
Curlew, Long B.																						
Dowitcher																10						
Duck, U.I.																						
Bufflehead					1				8		4	1										
Canvasback	75	2	9			3																
Cinnamon Teal							1															
Domestic/Hybrid		13	3					4	3			4		4	5				3	2		
Mallard	1				4	5	2		1		6			3					2			
Merganser, R.B.										1												
Pintail																						
Ruddy	2	9	4	1	3	3						1										
Scaup	2	6					2				3											
Egret, Common			1																	2		1
Snowy														1								1
Godwit, Marbled																						
Grebe, U.I.																						
Eared									1		3											
Pied B.										1												
Western			2				1			1		2										
Gull, U.I.			1	4				2			7				3							
Calif.																						
Herring																						
Ring B.																						
Western																						
Heron, G.B.			1																			
Kingfisher																						
Loon, Common							1							1								
R.T.																						
Peeps, U.I.		314																				
Dunlin						8																
Least Sandpiper																						
Spotted "																						
Western "																747						
Plover, Black-bellied																						
Killdeer					1	1		2			2			2								
Rail, Clapper																						
Snipe, Common																						
Tern, Arctic															2							
Caspian																						
Forster's																						
Turnstone, R.																						
Yellowlegs																						
Whimbrel																						
Willet		1	11	1		1			3		1			1								

BIRDS SIGHTED ON LARKSPUR FERRY TERMINAL PROJECT
AREA F - SAN QUENTIN MUD FLAT AND CHANNEL
OCTOBER 22, 1972 - JUNE 7, 1973

Date		1972 Oct 22	Oct 23	Nov 2	Nov 4	Nov 9	Nov 10	Nov 15	Nov 16	Nov 20	Nov 27	Nov 30	Dec 3	Dec 8	Dec 12	Dec 18	Dec 19	Dec 28	Dec 29
Time		5:30P	6:00P	3:50P	5:00P	8:15A	7:40A	12:20P	2:30P	3:50P	11:30A	2:55P	3:50P	8:10A	10:30A	3:45P	3:35P	1:20P	2:05P
Corr. low tide		7:12P	7:59P	4:27P	5:37P	7:18A	8:01A	1:51P	2:44P	6:01P	12:18P	3:36P	3:25P	7:01A	11:07A	5:01P	5:49P	2:06P	3:01P
Temp.		50°	60°	70°	50°	50°	58°	56°	65°	58°	59°	55°	53°	32°	44°	58°	65°	55°	59°
Wind vel.		0-5	0	0-5	10-20	0	0-5	10-25	0-5	0	0-5	10	10	0-5	5-10	5	0-5	15	3-10
Cloud cover		25%	0%	0%	30%	50%	100%	100%	100%	0%	0%	40%	100%	5%	100%	100%	90%	0%	40%
Avocet					1											8	24	14	
Coot		19	106	5	22	18	26	6	10	16			34	3	20		6		
Cormorant								1			2					2	1	6	
Curlew,	Long B.										2								
Dowitcher		1			18					1	2	1					2		
Duck,	U.I.										*3000*								537
	Bufflehead																		
	Canvasback			6		9										1000±	200+	350	
	Cinnamon Teal																		
	Domestic/Hybrid																		
	Mallard																		
	Merganser, R.B.																		
	Pintail		16	23											22	18			
	Ruddy										1							2	
	Scaup					21												6	
Egret,	Common	2	3							1									
	Snowy																		
Godwit,	Marbled										2								
Grebe,	U.I.																		
	Eared																		
	Pied B.																		
	Western			2	3	1			1		3	1		3					
Gull,	U.I.		80	137	173			3	74		6		282			216	168	254	210
	Calif.																		
	Herring																		
	Ring B.										55								
	Western	2								111									
Heron,	G.B.		2	2						1					1	2	1	3	3
Kingfisher						1													
Loon,	Common																		
	R.T.																		
Peeps,	U.I.	50			71											294	535	604	
	Dunlin		322	2								420+			11		348	37	533
	Least Sandpiper																		205
	Spotted "																		
	Western "		191	58								35					416	86	467
Plover,	Black-bellied	1	5	2	26				7	1		11			1	3	2	19	22
	Killdeer				1							3					3	2	1
Rail,	Clapper																		
Snipe,	Common																		
Tern,	Arctic																		
	Caspian																		
	Forster's																		
Turnstone,	R.																		
Yellowlegs																			
Whimbrel																			
Willet		3	13	24	42		2		45	16	131	177			2	128	145	198	213

*Migrating

BIRDS SIGHTED ON LARKSPUR FERRY TERM. PROJECT

AREA F - SAN QUENTIN MUD FLAT AND CHANNEL

OCTOBER 22, 1972 - JUNE 7, 1973

1973

Date	Jan 10	Jan 17	Jan 24	Jan 31	Feb 9	Feb 14	Feb 21	Mar 2	Mar 10	Mar 16	Mar 26	Mar 29	Apr 4	Apr 12	Apr 21	Apr 24	Apr 28	May 7	May 14	May 21	May 28	Jun 7
Time	9:35A	3:45P	1005A	3:55P	1150A	4:10P	9:50A	4:40P	9:15A	3:30P	2:20P	1250P	5:00P	1:30P	7:15A	9:30A	1:00P	8:45A	3:50P	8:15A	3:30P	9:05A
Corr. low tide	1035A	5:39P	1100A	5:12P	1117A	4:35P	9:14A	5:05P	1053A	4:49P	1228P	3:01P	6:39P	2:45P	8:58A	1128A	2:43P	1116A	5:12P	1011A	3:37P	6:11A
Temp.	53°	56°	48°	58°	60°	58°	62°	66°	62°	63°	68°	67°	66°	69°	65°	70°	60°	60°	65°	65°	75°	70°
Wind vel.	0-5	10-30	0-5	0-5	0-10	0-5	0	5-10	0-5	5-15	5-10	5-10	5-10	10	5-15	0-5	15-25	5-10	5-15	5-15	0-5	0-5
Cloud cover	100%	100%	100%	40%	95%	40%	30%	0%	100%	80%	25%	80%	0%	0%	0%	0%	40%	0%	60%	40%	10%	0%
Avocet						7							3		2							
Coot	4			28		25		60		68	24		35									
Cormorant	1											1										
Curlew, Long B.												1										
Dowitcher																6	3					
Duck, U.I.																						
Bufflehead				1		1		2	2	3												
Canvasback	2	3			4		480	252														
Cinnamon Teal																						
Domestic/Hybrid																						
Mallard																						
Merganser, R.B.																						
Pintail																						
Ruddy				1																		
Scaup	1		5				194					3										
Egret, Common		1					1	1				2	1	3	12	5		4		8	3	
Snowy							3	1					3	9	3	3		10		9		
Godwit, Marbled												1										
Grebe, U.I.																						
Eared															5							
Pied B.																						
Western							2	2				1	2									
Gull, U.I.	2	197	54	489	140	10		284	451	225	133	140		12		5				6		
Calif.																						
Herring																						
Ring B.							381															
Western																						
Heron, G.B.		1										1	3		4							
Kingfisher	1																					
Loon, Common											1											
R.T.												2			1							
Peeps, U.I.				849								2000±		1724	3400+	1500		418				
Dunlin		264		24	236	264	93	251			610		400									
Least Sandpiper		14									262											
Spotted "																						
Western "		162		2	288	296		277			872		2000±			1727	237					
Plover, Black-bellied		2	2	8	3	11		7	5		6	1	2	1	4	1	3					
Killdeer				2										4		2		1				
Rail, Clapper																						
Snipe, Common																						
Tern, Arctic															2	1						
Caspian																2						
Forster's												1		8		6	10	16				
Turnstone, R.																						
Yellowlegs																						
Whimbrel												1			4	12	12	7				
Willet		175	1	117	120	57	142	29	125	212	264	178	160	575	1500	25	6	7				

Bird Species Preference

in Census Areas

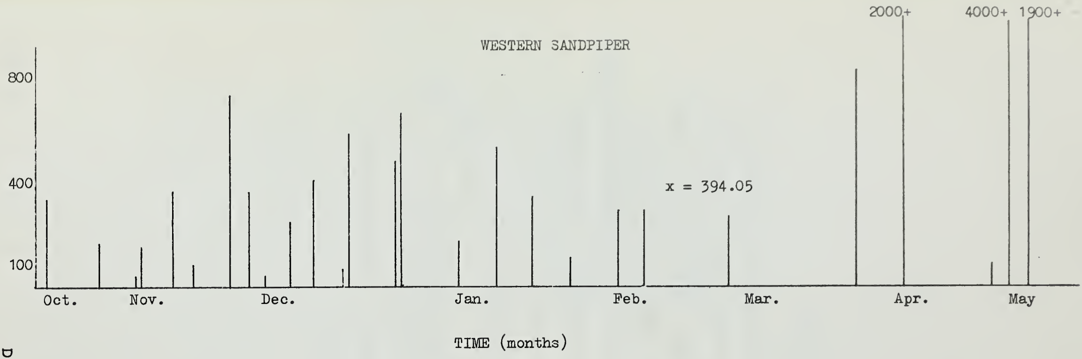
Avocet	Marbled Godwit
E	D
D	E
A	F
F	B
C	C
B	A

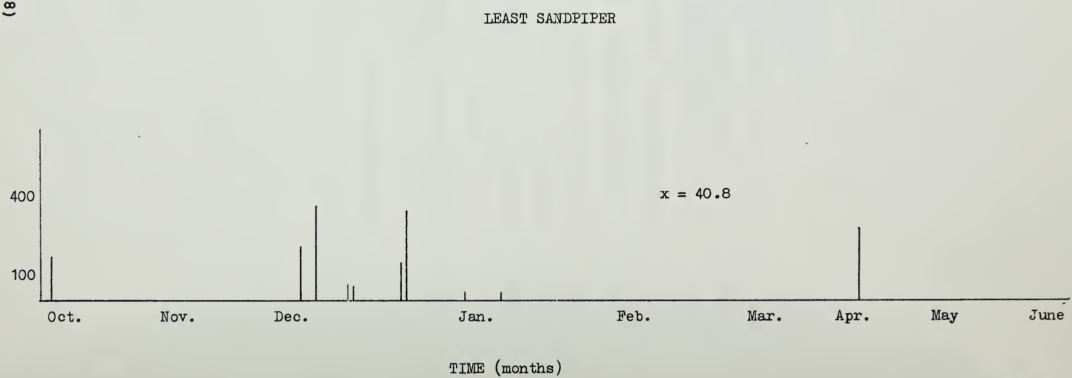
Shorebird census areas A-F arranged in magnitude array with increasing abundance from top to bottom. (Census from 22 October 1972 - 7 June 1973).

Bird Graphs

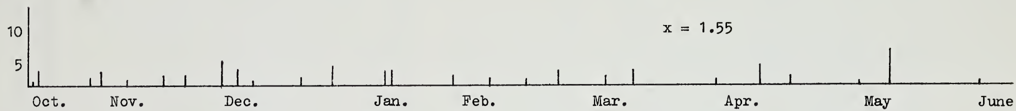
The following graphs illustrate the total number of birds of nine species for the six areas censused from 22 October 1972 to 7 June 1973. Of the approximately 35 total species recorded, the most numerous species are presented graphically : American Avocet (*Recurvirostra americana*), American Coot (*Fulica americana*), Black-bellied Plover (*Squatarola squatarola*), Dunlin (*Erolia alpina*), Killdeer (*Charadrius vociferus*), Least Sandpiper (*Erolia minutilla*), Marbled Godwit (*Limosa fedoa*), Western Sandpiper (*Ereunetes mauri*), and Willet (*Catoptrophorus semipalmatus*).

A mean value accompanies each graph which is derived from the total number of birds of that species divided by the number of census days. Total census days were 40 for all species except the Least and Western Sandpipers for which census days were 35. On five census days, poor weather made the identification of these two species unreliable.


WESTERN SANDPIPER
2000+
4000+
1900+
800
400
100
x = 394.05
Oct.
Nov.
Dec.
Jan.
Feb.
Mar.
Apr.
May
TIME (months)


LEAST SANDPIPER
400
100
x = 40.8
Oct.
Nov.
Dec.
Jan.
Feb.
Mar.
Apr.
May
June
TIME (months)

MARBLED GODWIT



AVOCET

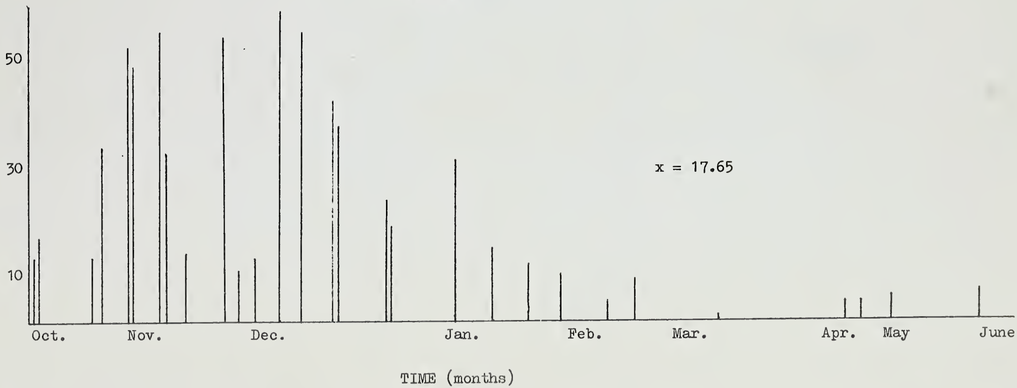


TABLE 16.

COOTS

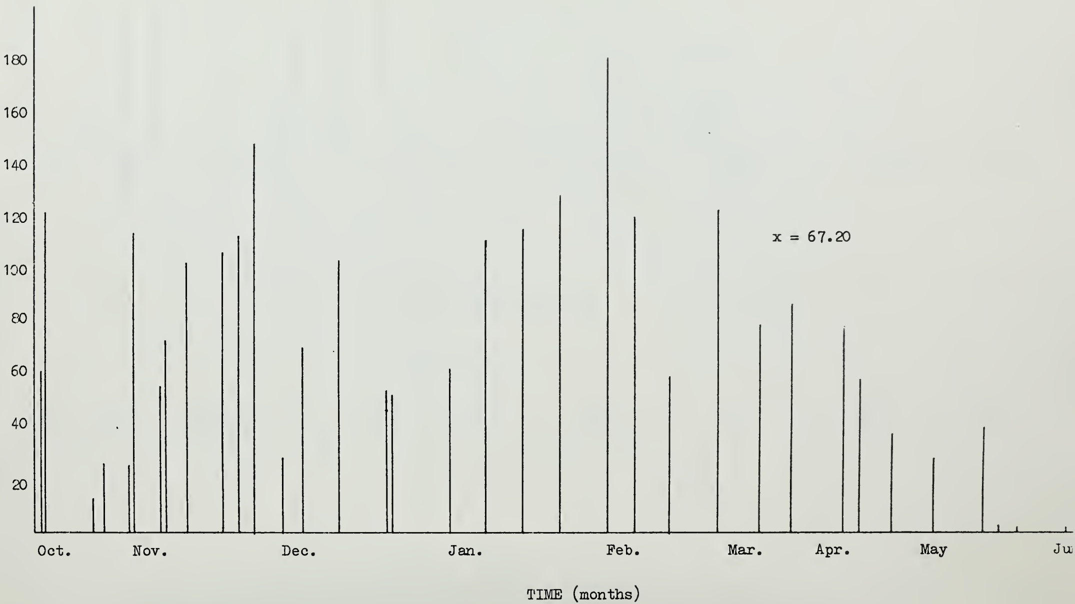
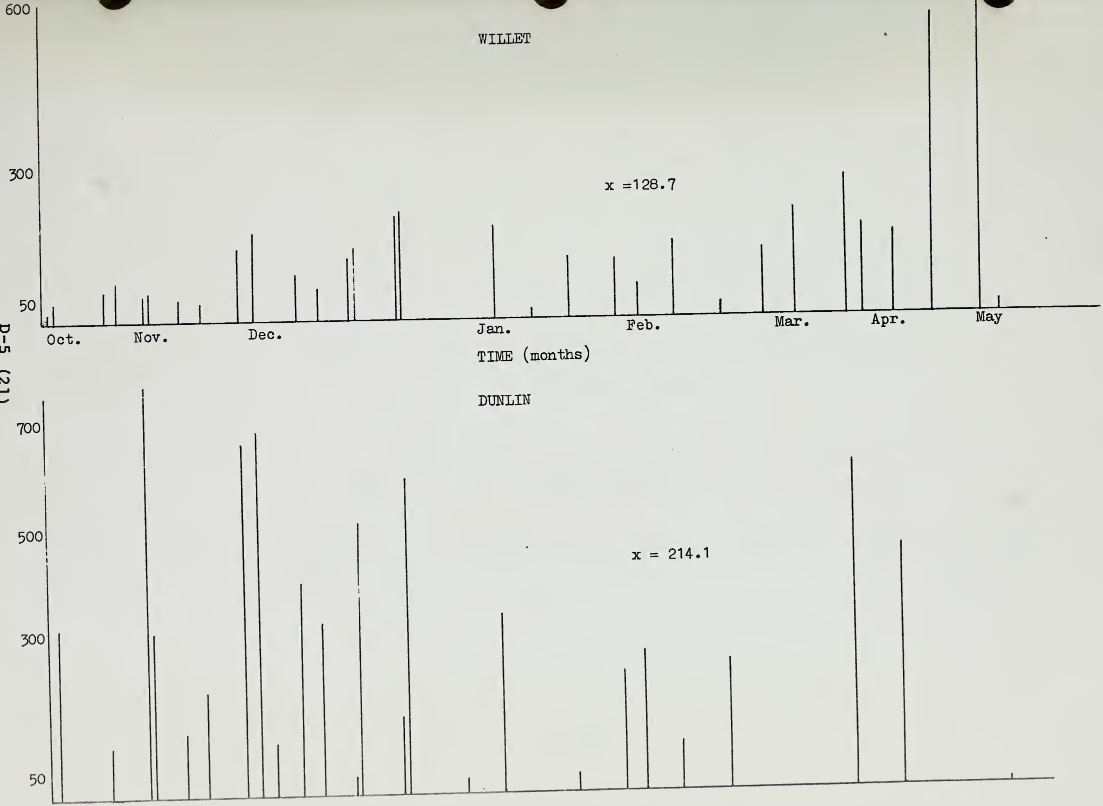


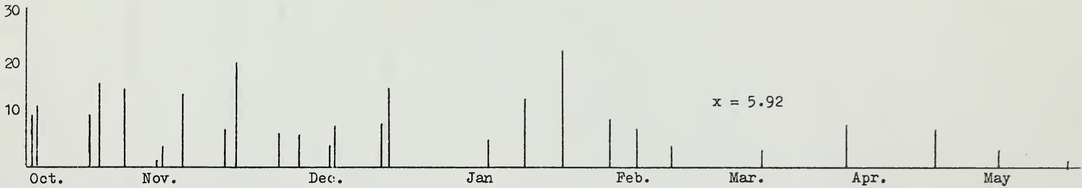
TABLE 17.



D-5 (21)

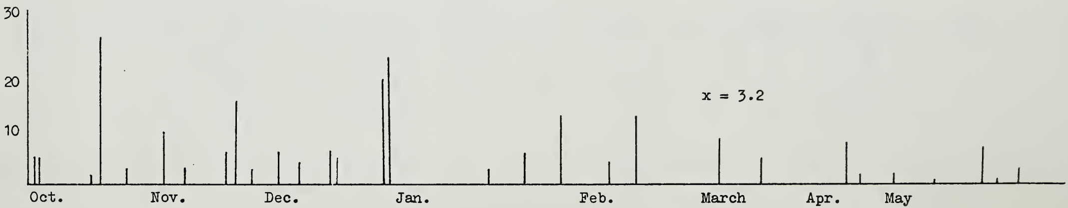
TABLE 18.

KILLDEER



TIME (months)

BLACK-BELLIED PLOVER



TIME (months)

TABLE 19.

Appendix E

SEDIMENT SAMPLE AND WATER QUALITY ANALYSES

In order to evaluate the results of these sediment analyses, a brief review of the current policy of the San Francisco Bay Regional Water Quality Control Board is presented.

Sediments are usually classified as non-polluted if the constituents listed below are less than the limits shown.

Chemical Oxygen Demand (COD)	50,000 mg/kg
Nitrogen, Kjeldahl	1,000 mg/kg
Volatile Solids	60,000 mg/kg
Oil and Grease	1,500 mg/kg
Lead	50 mg/kg
Mercury	1 mg/kg
Zinc	50 mg/kg

Other metals, hydrocarbons and chlorinated hydrocarbons are also tested and reported.

If the limits shown above are exceeded in the first four parameters (designated as polluted with organics), the spoils may be deposited in the vicinity of Alcatraz Island. If the sediments contain excess amounts of the metals (the last three items listed), they are considered as polluted with heavy metals and must be deposited on land or, if land disposal sites are not available, at the 100-fathom line in the Pacific Ocean (about 30 miles outside of the Golden Gate). The general level of Zinc content of sediments in the Bay Area exceeds the limit shown above; therefore, an excess in this single parameter is seldom used to determine that spoils are classified as polluted with heavy metals.

Review of each project is accomplished by the regulatory agencies on a case-by-case basis using the above policy as the guide. Changes in these procedures and policies are under consideration at present.

ENVIRONMENTAL QUALITY ANALYSTS INC.

A DIVISION OF BROWN AND CALDWELL
SAN FRANCISCO ALHAMBRA

J. T. NORGAARD President
T. V. LUTGE Vice-President
M. L. WHITT Environmental Engineer
M. N. LIPSCHUETZ Laboratories
C. P. WALTON Ecologist
R. D. SMITH Oceanographer

L157B

RECEIVED

HARDING, MILLER & ASSOCIATES

April 10, 1973

Mr. Richard G. Tait
Harding-Lawson Associates
155 Montgomery Street
San Francisco, California 94104

RESULTS OF ANALYSES OF SEDIMENT SAMPLES

Tabulated on attached sheets are our results on sixty sediment samples taken in connection with the Larkspur Ferry Project. These results have been tabulated by station for your convenience.

Chromium, lead, zinc, copper, nickel, and cadmium were all determined by atomic absorption spectrophotometry, using extraction techniques where necessary, on samples opened up by methods promulgated by Environmental Protection Agency. Mercury and arsenic were determined on aliquots of samples digested for mercury by Environmental Protection Agency method; arsenic was determined through method of additions to minimize the matrix effects in the arsine evolution step. Mercury was determined through use of the flameless atomic absorption technique. Kjeldahl nitrogen, chemical oxygen demand, volatile solids, grease and hydrocarbons in grease were determined by Environmental Protection Agency methods, where applicable, or by APHA methods (Standard Methods, 13th edition).

For pesticide residue analyses, the wet samples were extracted into 1:1 acetone: acetonitrile. Chlorinated hydrocarbons were partitioned into petroleum ether. Evaportions were by the Kadurna-Danish evaporator. Clean-up was by column chromatography using activated florisil. Detection was by GLC using the electron capture detector with the OV column, and the Dohrmann micro-coulometric chloride detector with the XE-60 column. Detection limits for the listed analytes are: PCB 1242 and 1254, 0.02 ppm; all others, 0.01 ppm. Detection limits for the pesticide residues not found are of the same order of magnitude.

We appreciate the opportunity to serve you in this matter.

Very truly yours,

ENVIRONMENTAL QUALITY ANALYSTS, INC.

Morris Lipschuetz

Morris Lipschuetz
Director of Laboratories

eb
encs

WATER QUALITY INVESTIGATIONS AND MARINE STUDIES / BIOLOGICAL AND CHEMICAL LABORATORIES

ENVIRONMENTAL QUALITY ANALYSTS INC. 66 MINT STREET SAN FRANCISCO CA 94103 (415)982-2442

ANALYTICAL RESULTS, BOTTOM SEDIMENT CORE SAMPLES

STATION 1 , SAMPLED February 23, 1973

Section	0-6"	6"-3½'	3½-6½'	6½-9½'	9½-12½'		
Lab Number	17192	17193	17194	17195	17196		
Mercury (Hg)	0.81	0.77	0.66	0.37	0.33		
Arsenic (As)	4.8	5.7	10	18	9.8		
Chromium (Cr)	170	320	280	270	360		
Lead (Pb)	71	61	54	44	42		
Zinc (Zn)	48	190	180	100	110		
Copper (Cu)	85	82	60	47	44		
Nickel (Ni)	88	200	190	180	230		
Cadmium (Cd)	2.1	3.4	1.4	1.3	1.0		
Total Kjeldahl Nitrogen (N)	2800	3100	2200	1900	1900		
Chemical Oxygen Demand (COD)	100,000	85,000	61,000	53,000	49,000		
Volatile Solids	103,000	88,000	81,000	70,000	75,000		
Grease (Hexane Extract)	6,100	4,500	2,900	1,500	1,100		
Hydrocarbons, % of grease	38	46	30	41	70		
Chlorinated Hydrocarbons							
PCB 1242	0.07	0.07	nd	nd	nd		
PCB 1254	0.27	0.73	0.12	0.10	nd		
DDD	0.02	0.04	0.03	0.02	0.02		
DDT	nd	nd	nd	nd	nd		
alphaChlordane	0.03	0.03	nd	nd	nd		
gammaChlordane	0.03	0.05	nd	nd	nd		
unidentified compounds	0.10	0.15	0.08	0.01	nd		

Except where noted, results are expressed as mg per kg dry solids.

nd = none detected

ANALYTICAL RESULTS, BOTTOM SEDIMENT CORE SAMPLES

STATION 2 , SAMPLED March 6, 1973

Section	0-6"	6"-3'	3'-6'	6'-9'	9'-12'	12'-15'	
Lab Number	17300	17301	17302	17303	17304	17305	
Mercury (Hg)	1.4	1.4	0.83	0.48	0.10	0.08	
Arsenic (As)	8.9	5.4	16	6.8	4.3	4.4	
Chromium (Cr)	150	160	140	150	95	100	
Lead (Pb)	60	62	60	36	18	19	
Zinc (Zn)	240	300	220	150	85	93	
Copper (Cu)	86	100	64	57	35	35	
Nickel (Ni)	75	77	67	73	44	48	
Cadmium (Cd)	3.2	3.0	1.7	0.66	0.50	0.79	
Total Kjeldahl Nitrogen (N)	4,900	4,000	2,400	2,100	1,400	1,700	
Chemical Oxygen Demand (COD)	130,000	108,000	71,000	62,000	54,000	44,000	
Volatile Solids	118,000	98,000	88,000	82,000	53,000	59,000	
Grease (Hexane Extract)	14,000	9,600	5,300	3,700	1,300	1,050	
Hydrocarbons, % of grease	30	22	37	23	< 1	1	
Chlorinated Hydrocarbons							
PCB 1242	nd	nd	nd	0.07	0.06	0.08	
PCB 1254	0.61	1.1	0.04	0.02	nd	nd	
DDD	0.03	0.08	0.06	nd	nd	nd	
DDT	nd	nd	nd	nd	nd	nd	
alphaChlordane	0.03	0.01	nd	nd	nd	nd	
gammaChlordane	0.02	0.02	nd	nd	nd	nd	
unidentified compounds	0.15	0.18	0.04	nd	nd	nd	

Except where noted, results are expressed as mg per kg dry solids.

nd = none detected

ANALYTICAL RESULTS, BOTTOM SEDIMENT CORE SAMPLES

STATION 3, SAMPLED February 27, 1973

Section	0-6"	6"-3½'	3½-6½'	6½-9½'	9½-12½'	12½-15½'	
Lab Number	17197	17198	17199	17200	17201	17202	
Mercury (Hg)	1.1	1.4	1.4	0.57	0.26	0.11	
Arsenic (As)	6.7	18	8.3	9.3	4.0	11	
Chromium (Cr)	120	130	120	100	110	80	
Lead (Pb)	75	77	72	53	38	28	
Zinc (Zn)	190	290	360	140	90	62	
Copper (Cu)	95	120	130	67	49	31	
Nickel (Ni)	43	54	52	55	55	36	
Cadmium (Cd)	2.8	4.9	1.9	1.4	0.72	0.31	
Total Kjeldahl Nitrogen (N)	3,000	3,000	4,200	2,100	2,000	1,400	
Chemical Oxygen Demand (COD)	100,000	120,000	110,000	65,000	61,000	54,000	
Volatile Solids	88,000	90,000	99,000	79,000	61,000	54,000	
Grease (Hexane Extract)	5,000	6,700	6,600	2,000	850	120	
Hydrocarbons, % of grease	72	57	59	88	97	91	
Chlorinated Hydrocarbons							
PCB 1242	nd	nd	nd	nd	nd	nd	
PCB 1254	0.39	0.73	0.70	nd	nd	nd	
DDD	0.08	0.08	0.09	0.18	nd	nd	
DDT	nd	nd	nd	nd	nd	nd	
alphaChlordane	0.04	0.04	0.05	nd	nd	nd	
gammaChlordane	0.04	0.04	0.07	nd	nd	nd	
unidentified compounds	0.09	0.17	0.37	nd	nd	nd	

Except where noted, results are expressed as mg per kg dry solids.

nd = none detected

ANALYTICAL RESULTS, BOTTOM SEDIMENT CORE SAMPLES

STATION 4 , SAMPLED February 28, 1973

Section	0-6"	6"-3½'	3½-6½'	6½-9½'	9½-12½'	12½-15½'	15½-18½'
Lab Number	17203	17204	17205	17206	17207	17208	17215
Mercury (Hg)	0.78	1.0	0.51	0.54	0.49	0.22	0.08
Arsenic (As)	5.9	9.4	7.4	15	6.5	8.0	7.7
Chromium (Cr)	110	110	110	120	120	99	98
Lead (Pb)	63	62	61	56	53	35	31
Zinc (Zn)	110	160	170	180	140	97	66
Copper (Cu)	68	93	80	88	66	40	39
Nickel (Ni)	53	51	56	54	63	50	44
Cadmium (Cd)	2.4	2.0	0.79	1.2	1.4	0.91	0.85
Total Kjeldahl Nitrogen (N)	2,400	2,900	2,000	2,600	2,100	1,200	1,400
Chemical Oxygen Demand (COD)	80,000	92,000	72,000	62,000	65,000	70,000	50,000
Volatile Solids	73,000	81,000	83,000	76,000	74,000	60,000	52,000
Grease (Hexane Extract)	2,400	5,000	3,800	2,900	2,100	1,300	9.7
Hydrocarbons, % of grease	85	58	66	68	55	87	< 1
Chlorinated Hydrocarbons							
PCB 1242	nd	0.13	0.06	0.03	nd	0.10	0.05
PCB 1254	0.43	0.58	nd	nd	nd	nd	nd
DDD	0.03	0.04	0.09	0.03	nd	nd	nd
DDT	0.03	nd	0.03	nd	0.04	nd	nd
alphaChlordane	0.03	nd	nd	nd	nd	nd	nd
gammaChlordane	0.03	nd	nd	nd	nd	nd	nd
unidentified compounds	0.21	0.13	nd	nd	nd	nd	nd

Except where noted, results are expressed as mg per kg dry solids.

nd = none detected

ANALYTICAL RESULTS, BOTTOM SEDIMENT CORE SAMPLES

STATION 5 . SAMPLED February 28, 1973

Section	0-6"	6"-3½'	3½-6½'	6½-9½'	9½-12½'	12½-15½'	
Lab Number	17209	17210	17211	17212	17213	17214	
Mercury (Hg)	0.49	1.2	1.5	0.13	0.10	0.07	
Arsenic (As)	5.5	9.6	10	5.5	4.8	7.3	
Chromium (Cr)	110	100	120	99	95	120	
Lead (Pb)	51	63	71	35	30	25	
Zinc (Zn)	130	270	410	97	65	54	
Copper (Cu)	61	79	110	48	39	32	
Nickel (Ni)	49	52	60	46	39	48	
Cadmium (Cd)	1.4	1.6	2.1	0.91	0.31	0.73	
Total Kjeldahl Nitrogen (N)	1,800	2,300	4,200	1,600	1,800	940	
Chemical Oxygen Demand (COD)	51,000	79,000	110,000	64,000	68,000	33,000	
Volatile Solids	60,000	75,000	89,000	58,000	56,000	39,000	
Grease (Hexane Extract)	940	5,100	7,200	190	21	23	
Hydrocarbons, % of grease	100	56	45	90	< 1	67	
Chlorinated Hydrocarbons							
PCB 1242	nd	nd	nd	nd	nd	0.02	
PCB 1254	0.27	0.03	0.10	nd	nd	nd	
DDD	0.02	0.10	0.08	0.02	nd	nd	
DDT	nd	0.20	0.02	nd	nd	nd	
alphaChlordane	0.02	0.04	0.05	nd	nd	nd	
gammaChlordane	0.02	0.02	0.05	nd	nd	nd	
unidentified compounds	0.04	0.12	0.14	nd	nd	nd	

Except where noted, results are expressed as mg per kg dry solids.

nd = none detected

ANALYTICAL RESULTS, BOTTOM SEDIMENT CORE SAMPLES

STATION 6 , SAMPLED March 1, 1973

Section	0-6"	6"-3'	3'-6'	6'-9'	9'-12'	12'-15'	15'-18'
Lab Number	17216	17217	17218	17219	17220	17221	17222
Mercury (Hg)	0.44	0.34	0.10	0.08	0.08	0.08	0.09
Arsenic (As)	6.8	9.8	10	5.4	2.6	2.3	4.9
Chromium (Cr)	100	100	81	76	98	95	110
Lead (Pb)	61	35	24	24	29	30	26
Zinc (Zn)	80	91	56	57	62	63	56
Copper (Cu)	34	41	30	38	35	36	25
Nickel (Ni)	44	46	32	32	39	42	44
Cadmium (Cd)	0.28	0.59	0.21	0.78	0.43	0.33	0.80
Total Kjeldahl Nitrogen (N)	1,100	700	1,000	1,100	1,400	1,500	1,200
Chemical Oxygen Demand (COD)	34,000	34,000	60,000	53,000	66,000	60,000	48,000
Volatile Solids	40,000	43,000	42,000	38,000	51,000	52,000	46,000
Grease (Hexane Extract)	390	430	120	170	200	130	93
Hydrocarbons, % of grease	< 1	2	< 1	< 1	4	< 1	< 1
Chlorinated Hydrocarbons							
PCB 1242	0.02	0.03	0.04	0.03	0.04	0.06	0.04
PCB 1254	nd	nd	nd	nd	nd	nd	nd
DDD	nd	nd	nd	nd	nd	nd	nd
DDT	nd	nd	nd	nd	nd	nd	nd
alphaChlordane	nd	nd	nd	nd	nd	nd	nd
gammaChlordane	nd	nd	nd	nd	nd	nd	nd
unidentified compounds	nd	nd	nd	nd	nd	nd	nd

Except where noted, results are expressed as mg per kg dry solids.

nd = none detected

ANALYTICAL RESULTS, BOTTOM SEDIMENT CORE SAMPLES

STATION 7, SAMPLED March 1, 1973

Section	0-6"	6"-3'	3'-6'	6'-9'	9'-12'	12'-15'	15'-18'
Lab Number	17223	17224	17225	17226	17227	17228	17229
Mercury (Hg)	0.39	0.34	0.09	0.08	0.09	0.10	0.10
Arsenic (As)	7.8	16	4.9	5.2	18	5.0	3.4
Chromium (Cr)	100	100	72	74	90	96	100
Lead (Pb)	34	33	24	24	16	20	20
Zinc (Zn)	93	93	48	58	76	77	90
Copper (Cu)	27	35	18	23	31	31	36
Nickel (Ni)	46	50	29	31	46	46	52
Cadmium (Cd)	0.60	0.65	0.67	0.95	0.30	0.63	0.56
Total Kjeldahl Nitrogen (N)	900	1,000	1,200	1,400	1,500	1,100	1,300
Chemical Oxygen Demand (COD)	27,000	35,000	55,000	53,000	61,000	42,000	55,000
Volatile Solids	41,000	46,000	42,000	45,000	51,000	47,000	52,000
Grease (Hexane Extract)	270	180	240	140	69	960	620
Hydrocarbons, % of grease	< 1	9	3	< 1	< 1	< 1	2
Chlorinated Hydrocarbons							
PCB 1242	nd	0.02	0.05	0.05	0.10	0.08	0.08
PCB 1254	nd	nd	nd	nd	nd	nd	nd
DDD	nd	nd	nd	nd	nd	nd	nd
DDT	nd	nd	nd	nd	nd	nd	nd
alphaChlordane	nd	nd	nd	nd	nd	nd	nd
gammaChlordane	nd	nd	nd	nd	nd	nd	nd
unidentified compounds	nd	nd	nd	nd	nd	nd	nd

Except where noted, results are expressed as mg per kg dry solids.

nd = none detected

ANALYTICAL RESULTS, BOTTOM SEDIMENT CORE SAMPLES

STATION 8 , SAMPLED March 7, 1973

Section	0-6"	6"-3'	3'-6'	6'-9'	9'-12'	12'-15'	
Lab Number	17346	17347	17348	17349	17350	17351	
Mercury (Hg)	0.42	0.35	0.18	0.13	0.10	0.12	
Arsenic (As)	4.7	3.7	6.3	7.5	5.0	3.0	
Chromium (Cr)	110	99	76	100	110	100	
Lead (Pb)	26	23	19	18	17	15	
Zinc (Zn)	110	91	69	75	80	87	
Copper (Cu)	35	33	22	27	32	32	
Nickel (Ni)	51	46	38	42	44	44	
Cadmium (Cd)	0.47	0.53	0.80	1.1	0.68	0.63	
Total Kjeldahl Nitrogen (N)	1,000	1,400	1,400	1,400	1,300	1,300	
Chemical Oxygen Demand (COD)	36,000	42,000	66,000	62,000	58,000	54,000	
Volatile Solids	52,000	60,000	61,000	55,000	54,000	53,000	
Grease (Hexane Extract)	1,300	1,500	860	1,200	1,400	770	
Hydrocarbons, % of grease	8	11	2	< 1	< 1	2	
Chlorinated Hydrocarbons							
PCB 1242	0.06	0.06	0.03	0.04	0.07	0.05	
PCB 1254	nd	nd	nd	nd	nd	nd	
DDD	nd	nd	nd	nd	nd	nd	
DDT	nd	nd	nd	nd	nd	nd	
alphaChlordane	nd	nd	nd	nd	nd	nd	
gammaChlordane	nd	nd	nd	nd	nd	nd	
unidentified compounds	nd	nd	nd	nd	nd	nd	

Except where noted, results are expressed as mg per kg dry solids.

nd = none detected

ANALYTICAL RESULTS, BOTTOM SEDIMENT CORE SAMPLES

STATION 9 , SAMPLED March 2, 1973

Section	0-6"	6"-3'	3'-6'	6'-9'	9-12½'		
Lab Number	17239	17240	17241	17242	17243		
Mercury (Hg)	0.22	0.28	0.14	0.13	0.14		
Arsenic (As)	4.2	7.1	6.7	4.0	7.2		
Chromium (Cr)	80	93	84	82	81		
Lead (Pb)	22	17	16	23	27		
Zinc (Zn)	86	87	86	89	82		
Copper (Cu)	28	28	33	52	31		
Nickel (Ni)	45	41	41	39	40		
Cadmium (Cd)	0.69	0.88	0.83	1.5	1.4		
Total Kjeldahl Nitrogen (N)	1,100	1,600	1,300	1,300	1,300		
Chemical Oxygen Demand (COD)	49,000	59,000	58,000	41,000	49,000		
Volatile Solids	46,000	53,000	53,000	60,000	51,000		
Grease (Hexane Extract)	540	830	870	66	750		
Hydrocarbons, % of grease	< 1	< 1	2	< 1	< 1		
Chlorinated Hydrocarbons							
PCB 1242	0.13	0.10	0.07	0.08	0.03		
PCB 1254	nd	nd	nd	nd	nd		
DDD	nd	nd	nd	nd	nd		
DDT	nd	nd	nd	0.02	0.02		
alphaChlordane	nd	nd	nd	nd	nd		
gammaChlordane	nd	nd	nd	nd	nd		
unidentified compounds	nd	nd	nd	nd	nd		

Except where noted, results are expressed as mg per kg dry solids.

nd = none detected

ANALYTICAL RESULTS, BOTTOM SEDIMENT CORE SAMPLES

STATION 10 , SAMPLED March 2, 1973

Section	0-6"	6"-3'	3'-6'	6'-9'	9'-14'		
Lab Number	17244	17245	17246	17247	17248		
Mercury (Hg)	0.56	0.29	0.15	0.09	0.10		
Arsenic (As)	5.9	9.5	4.6	5.7	13		
Chromium (Cr)	110	100	91	71	85		
Lead (Pb)	24	20	14	20	21		
Zinc (Zn)	140	84	71	72	89		
Copper (Cu)	63	37	24	26	32		
Nickel (Ni)	47	40	42	35	39		
Cadmium (Cd)	0.83	0.45	0.75	1.3	0.94		
Total Kjeldahl Nitrogen (N)	1,600	1,600	1,100	1,500	1,200		
Chemical Oxygen Demand (COD)	43,000	59,000	51,000	50,000	56,000		
Volatile Solids	58,000	60,000	45,000	48,000	59,000		
Grease (Hexane Extract)	1,100	700	980	490	810		
Hydrocarbons, % of grease	< 1	< 1	< 1	< 1	< 1		
Chlorinated Hydrocarbons							
PCB 1242	nd	nd	0.06	0.03	0.05		
PCB 1254	nd	nd	nd	nd	nd		
DDD	nd	nd	nd	nd	nd		
DDT	nd	nd	nd	nd	nd		
alphaChlordane	nd	nd	nd	nd	nd		
gammaChlordane	nd	nd	nd	nd	nd		
unidentified compounds	nd	nd	nd	0.02	0.02		

Except where noted, results are expressed as mg per kg dry solids.

nd = none detected

WATER QUALITY INVESTIGATIONS AND MARINE STUDIES / BIOLOGICAL AND CHEMICAL LABORATORIES

ENVIRONMENTAL QUALITY ANALYSTS INC. 66 MINT STREET SAN FRANCISCO CA 94103 (415) 982-2442

ANALYTICAL RESULTS, BOTTOM SEDIMENT CORE SAMPLES

STATION 11 , SAMPLED March 2, 1973

Section	0-6"	6"-3'	3'-6'	6'-9'	9'-12'			
Lab Number	18012	18013	18014	18015	18016			
Mercury (Hg)	0.11	0.094	0.099	0.10	0.11			
Arsenic (As)	6.0	4.2	6.7	7.5	6.6			
Chromium (Cr)	82	87	84	84	83			
Lead (Pb)	18	15	17	13	17			
Zinc (Zn)	160	180	160	180	170			
Copper (Cu)	34	36	36	35	37			
Nickel (Ni)	40	43	42	44	42			
Cadmium (Cd)	0.96	1.1	1.9	[illegible]	[illegible]			
Total Kjeldahl Nitrogen (N)	2,000	2,000	1,600	1,800	1,600			
Chemical Oxygen Demand (COD)	62,000	60,000	56,000	53,000	51,000			
Volatile Solids	50,000	54,000	54,000	57,000	55,000			
Grease (Hexane Extract)	1,800	2,900	4,500	3,700	3,000			
Hydrocarbons, % of grease	13	3.9	2.8	2.8	4.6			
Chlorinated Hydrocarbons								
PCB 1242	nd	nd	nd	nd	nd			
PCB 1254	nd	nd	nd	nd	nd			
DDD	nd	nd	nd	nd	nd			
DDT	nd	nd	nd	nd	nd			
alphaChlordane	nd	nd	nd	nd	nd			
gammaChlordane	nd	nd	nd	nd	nd			
unidentified compounds	nd	nd	nd	nd	nd			

Except where noted, results are expressed as mg per kg dry solids.

nd = none detected

Morris Sylvacheity

WATER QUALITY INVESTIGATIONS AND MARINE STUDIES / BIOLOGICAL AND CHEMICAL LABORATORIES

ANALYTICAL RESULTS, BOTTOM SEDIMENT CORE SAMPLES

STATION 12 , SAMPLED March 2, 1973

Section	0-6"	6"-3'	3'-6'	6'-9'	9'-12'			
Lab Number	18017	18018	18019	18020	18021			
Mercury (Hg)	0.34	0.49	0.19	0.10	0.19			
Arsenic (As)	9.7	7.9	4.4	5.3	4.2			
Chromium (Cr)	87	99	79	89	83			
Lead (Pb)	27	26	15	16	16			
Zinc (Zn)	180	170	140	160	170			
Copper (Cu)	45	47	31	33	32			
Nickel (Ni)	40	46	41	44	43			
Cadmium (Cd)	1.5	1.4	1.2	1.5	0.73			
Total Kjeldahl Nitrogen (N)	1,700	1,700	1,800	1,900	1,800			
Chemical Oxygen Demand (COD)	34,000	39,000	54,000	49,000	46,000			
Volatile Solids	66,000	65,000	53,000	53,000	54,000			
Grease (Hexane Extract)	2,500	2,200	670	1,200	2,600			
Hydrocarbons, % of grease	7.1	2.7	5.3	3.0	1.0			
Chlorinated Hydrocarbons								
PCB 1242	nd	nd	0.05	0.05	0.02			
PCB 1254	nd	nd	nd	nd	nd			
DDD	nd	nd	nd	nd	nd			
DDT	nd	nd	nd	nd	nd			
alphaChlordane	nd	nd	nd	nd	nd			
gammaChlordane	nd	nd	nd	nd	nd			
unidentified compounds	nd	nd	nd	nd	nd			

Except where noted, results are expressed as mg per kg dry solids.

nd = none detected

Morris Lefschetz

WATER QUALITY INVESTIGATIONS AND MARINE STUDIES / BIOLOGICAL AND CHEMICAL LABORATORIES

ANALYTICAL RESULTS, BOTTOM SEDIMENT CORE SAMPLES

STATION 13 , SAMPLED March 2, 1973

Section	0-6"	6"-3'	3'-6'	6'-9'			
Lab Number	18022	18023	18024	18025			
Mercury (Hg)	0.51	0.50	0.46	0.36			
Arsenic (As)	8.6	11	6.8	17			
Chromium (Cr)	97	94	92	90			
Lead (Pb)	35	39	29	26			
Zinc (Zn)	220	220	210	180			
Copper (Cu)	56	52	46	44			
Nickel (Ni)	45	47	43	43			
Cadmium (Cd)	1.2	1.6	1.8	1.4			
Total Kjeldahl Nitrogen (N)	1,800	1,900	1,500	1,300			
Chemical Oxygen Demand (COD)	43,000	41,000	38,000	37,000			
Volatile Solids	64,000	66,000	67,000	62,000			
Grease (Hexane Extract)	2,800	1,100	1,200	1,000			
Hydrocarbons, % of grease	3.2	11	9.8	2.9			
Chlorinated Hydrocarbons							
PCB 1242	0.08	0.05	nd	0.08			
PCB 1254	0.02	0.03	nd	nd			
DDD	nd	nd	nd	nd			
DDT	nd	nd	nd	nd			
alphaChlordane	nd	nd	nd	nd			
gammaChlordane	nd	nd	nd	nd			
unidentified compounds	nd	nd	nd	nd			

Except where noted, results are expressed as mg per kg dry solids.

nd = none detected

Morris Lipschultz

WATER QUALITY INVESTIGATIONS AND MARINE STUDIES / BIOLOGICAL AND CHEMICAL LABORATORIES

ENVIRONMENTAL QUALITY ANALYSTS INC. 66 MINT STREET SAN FRANCISCO CA 94103 (415)982-2442

Appendix F

Noise Impact Study

July 11, 1973

by

Bolt, Beranek and Newman, Inc.
San Francisco, California

633 Battery Street
One Jackson Place
San Francisco, Calif. 94111
Telephone (415) 391-7610

TWENTY FIFTH ANNIVERSARY

Bolt Beranek and Newman Inc.

11 July 1973

Mrs. Phyllis Faber
Madrone Associates
35 Mitchell Boulevard
San Rafael, CA 94901

Subject: Noise Impact Study
Larkspur Ferry Terminal
BBN Project #145427

Dear Mrs. Faber:

This letter report summarizes the results of our study to determine the present ambient noise environment at the subject site and predict the noise impact of the Ferry Terminal operation on adjacent land uses.

We are including as Appendix I some definitions of the terms used to describe the noise levels. Appendix II is a description of our measurement procedures.

I SUMMARY OF RESULTS

Based on the results of our study, there will be negligible impact on adjacent land uses due to the operation of the ferryboats themselves. The traffic flows for 1975 and 1990 indicate a slight impact on adjacent land uses from the increased car, truck and bus traffic relating to the Ferry Terminal operation.

II INTERPRETATION OF RESULTS

A. NOISE FROM FERRYBOAT OPERATION

1. Criteria

(a) SENEL

In determining people's assessment of aircraft sounds, the intensity, frequency content and duration (length) of the noise signal have been shown to be important attributes. The approach and departure of a ferryboat past a given observer on shore would be similar in many respects to the passing of an aircraft overhead since the turbine engine noise source on the boat is analogous to the aircraft engine noise source. Thus, we can use certain criteria for land use near airports to evaluate the noise environment near the Larkspur Ferry Terminal.

For this reason, we have chosen the "Single Event Noise Exposure Level" (SENEL) to describe each ferryboat pass. The SENEL takes into account each of the attributes mentioned above by integrating with time the A-weighted sound level during the period of the event. For a moving source, whose amplitude at a receiver point varies with time, the integration interval typically corresponds to the duration of the upper 20 dBA of the signal.

$$\text{SENEL} = 10 \log \left[\int_{T_1}^{T_2} \text{antilog} \left(\frac{AL[t]}{10}\right) dt \right]$$

Where: AL [t] = instantaneous A-level at time t.
T_1 and T_2 bracket the time during which the noise signal occurs.

(b) CNEL

Study and accumulated experience indicate that the meaningful descriptions of the noise environment require consideration of the noise level of individual events plus consideration of the number of events occurring and the time of day in which the events occur. The Community Noise Equivalent Level (CNEL) takes these factors into consideration by summing, on an energy basis, each SENEL value for the time of day the intrusion occurred. These weighting factors account for the increased annoyance of transient noises during the evening and nighttime hours, thus:

$$\text{CNEL} = 10 \log \left[\sum_{i=1}^{n} \frac{W_i \cdot \text{antilog} \frac{\text{SENEL}_i}{10}}{86400} \right]$$

Where: W_i = time of day weighting factor for event i:

1 for 0700 - 1900

3 for 1900 - 2200

10 for 2200 - 0700

86400 = number of seconds in a day

n = number of events

The CNEL may also be defined in terms of the Hourly Noise Level (HNL) where HNL is the average noise level (on an energy basis) during a particular hour.

2. Estimated Noise Levels

(a) Existing Conditions

Figure 1 shows the two ambient measurement positions. Figures 2 and 3 show the statistical distribution of A-weighted noise levels at the two ambient measurement positions.

At Positions 1 and 2, the 1% levels (L_1) represent the peak noise levels from very large trucks on Sir Francis Drake Boulevard. The L_{10} levels are sensitive to the truck density on Sir Francis Drake. These are the intrusions that often disturb sleep or interrupt a train of thought. The L_{50} levels represent the median or average noise levels. Passenger cars on Sir Francis Drake, and to a lesser extent on US 101, as well as the noise from quarry operations, are the major contributors to this level. The L_{90} level can be considered the steady state "background" noise coming from traffic on US 101 as well as from a multitude of other sources in all directions, none of them individually recognizable.

The L_{10} noise levels at Position 1 are higher than those at Position 2. They are higher by the amount we would predict considering the distance of each site from the truck traffic on Sir Francis Drake and the length of Sir Francis Drake that is visible from each measurement site. Therefore, from our measurements we can conclude that the ambient, or "background" L_{10} noise levels were dominated by truck traffic on Sir Francis Drake Boulevard.

From the data on Figures 1 and 2 we can calculate the $L_{equivalent}$ for our 14 hour ambient samples at each site. L_{eq} is defined as the mean-square, A-weighted sound level of a sufficiently long sample of noise: it is equivalent to the energy mean noise level in dBA as computed by the equation below.

$$L_{eq} \approx L_{50} + \frac{(L_{10} - L_{90})^2}{60}$$

The L_{eq} at Position 1 was 59 dBA

The L_{eq} at Position 2 was 54 dBA

(b) Future Conditions

To develop the estimated future noise levels of the ferryboat operation, we have used the following information provided by you:

a. Two boats per hour - 1975
b. Three boats per hour - 1990
c. Terminal operation between 6:00am and 8:00pm
d. 20 knots or 34 feet per second boat speed.

The boat designers, Nickum & Spaulding Associates, Inc., have supplied us with a figure of 83 dBA measured 100 ft. from the boat for the noise level of an operating ferry. The boat specification limits the boat noise to a maximum of 90 dBA at 100 ft. We used these two figures to develop a range of SENEL's for any single boat pass observed from our ambient measurement position #1.

This range is SENEL 84 to SENEL 91. From these values, for a schedule of two boats per hour, the HNL at Position 1 would be in the range of HNL 54 to HNL 61. For three boats per hour the range would be HNL 56 to HNL 63.

3. Impact

The HNL calculated for the boat noise also corresponds to the L_{eq} value for the period and thus can be compared with the present ambient L_{eq} in the assessment of potential impact. The L_{eq} of the present ambient environment at Position 1 is 59 dBA and the predicted L_{eq} due to two ferryboat operations per hour is 54-61 dBA; thus, the L_{eq} of the future environment is anticipated to increase by 2 dBA at the most. It is generally agreed that the L_{eq} of an environment must be increased by at least 5 dBA to have other than a slight impact on the surrounding community. On the basis of the foregoing, we conclude that the noise of ferryboat operations will have negligible environmental impact. The 1990 schedule of three boats per hour will produce an L_{eq} in the range of 56-63 dBA and thus elevate the present ambient by a maximum of 4 dBA; however, this increase is still within the allowable limit for negligible impact.

The HNL's calculated for Position 2 are lower than those at Position 1 because of the greater distance from the boat route. The present L_{eq} of the prevailing ambient is also lower by 5 dBA. However, the predicted increase in L_{eq} due to ferryboat operations is less than 5 dBA and thus will also represent negligible environmental impact in that area.

The CNEL calculated for a 24-hour period at Position 1, with three boats operating per hour (1990), is in the range of CNEL 56 to CNEL 63 and compares favorably with the trend in the State of California legislation to establish a maximum limit in residential areas of CNEL 65.

One more evaluation factor that might be considered is the current Federal regulation on acceptable environmental noise for new housing financed by FHA/HUD as set forth in the HUD Departmental Circular 1390.2. Using the present guidelines that have been established by HUD for areas exposed to aircraft noise, the environmental classification, assuming ferryboat operations are equivalent, would be "normally acceptable."

B. NOISE FROM VEHICULAR TRAFFIC

1. Criteria

The National Cooperative Highway Research Program Report 117 suggests design criteria for traffic noise which have been derived from past studies, tests and other considerations. These criteria specify maximum noise levels that would be considered by the average individual to be acceptable with respect to speech, radio and TV interference, sleep interference, and annoyance. An L_{10} of 56 dBA during a daytime period is the recommended design limit criterion outside residential dwellings. According to these procedures, impact is evaluated on the basis of the increase in level introduced by a new highway noise source. However, if the existing ambient is already above the design criteria, an increase of 1-5 dBA would receive a classification of SOME IMPACT. An increase of 6 dBA or more would be classified as GREAT IMPACT.

2. Estimated Noise Levels

(a) Existing Conditions

Figures 2 and 3 show the statistical distribution of A-weighted noise levels at the two ambient measurement positions.

To be consistent with the procedures of the Highway Design Guide (Report 117), this report will use single number descriptors to account for the three dimensions of environmental noise: its level, frequency spectrum, and time varying character. These descriptors are the L_{10} and L_{50}, the A-weighted sound levels exceeded 10% and 50% of the time respectively.

Since the ambient levels at both measurement positions were dominated by truck traffic which occurred throughout the day and did not peak at any one particular hour, we have used the L_{10} values over the 14 hour period of the ambient measurements, averaged on an energy basis, to describe existing environmental conditions. The ambient noise levels at Positions 1 and 2, determined on this basis, are L_{10} = 65 dBA and L_{10} = 57 dBA respectively.

(b) Future Conditions

The predicted future traffic noise levels at Positions 1 and 2 are based on the following peak hour traffic flows along East Sir Francis Drake supplied by your office.

	Cars	Trucks	Buses	Speed
1975	1860	50	20	35 mph
1990	4815	185	30	35 mph

The predicted L_{10} levels are as follows:

	1975	1990
Position 1 North of East Sir Francis Drake	L_{10} = 69 dBA	L_{10} = 77 dBA
Position 2 Along Corte Madera Creek	L_{10} = 57 dBA	L_{10} = 60 dBA

(c) Impact

The increase from existing L_{10} noise levels to future L_{10} noise levels is summarized below.

	Existing L_{10} (measured)	Estimated Future L_{10} 1975	1990	Increase Above Existing Levels 1975	1990
Position 1 North of East Sir Francis Drake	72 dBA	69 dBA	77 dBA	+4 dBA	+5 dBA
Position 2 Along Corte Madera Creek	57 dBA	57 dBA	60 dBA	0 dBA	+3 dBA

Because the existing L_{10} levels at both locations are already above the NCHRP criterion of 56 dBA, the increase in traffic accompanying the Ferry Terminal operation would receive the classification of SOME IMPACT on the basis of this particular guideline

We anticipate a negligible increase in traffic noise on US 101 and thus no impact on adjacent land uses due to the Ferry Terminal operations.

A comparison of the existing and future traffic noise levels due to cars and buses moving in and out of the Terminal parking lot and along East Sir Francis Drake, interpreted on the basis of criteria specified in NCHRP Report 117, results in a rating of SOME IMPACT on adjacent residential land uses based on 1975 and 1990 estimated traffic volumes.

* * *

We hope this report adequately serves your requirements for assessing the potential environmental impact of the proposed Larkspur Ferry Terminal due to noise. Please do not hesitate to call us if you have any specific questions or if we can assist you with any other problems.

Sincerely yours,

BOLT BERANEK AND NEWMAN INC.

Joel A. Lewitz

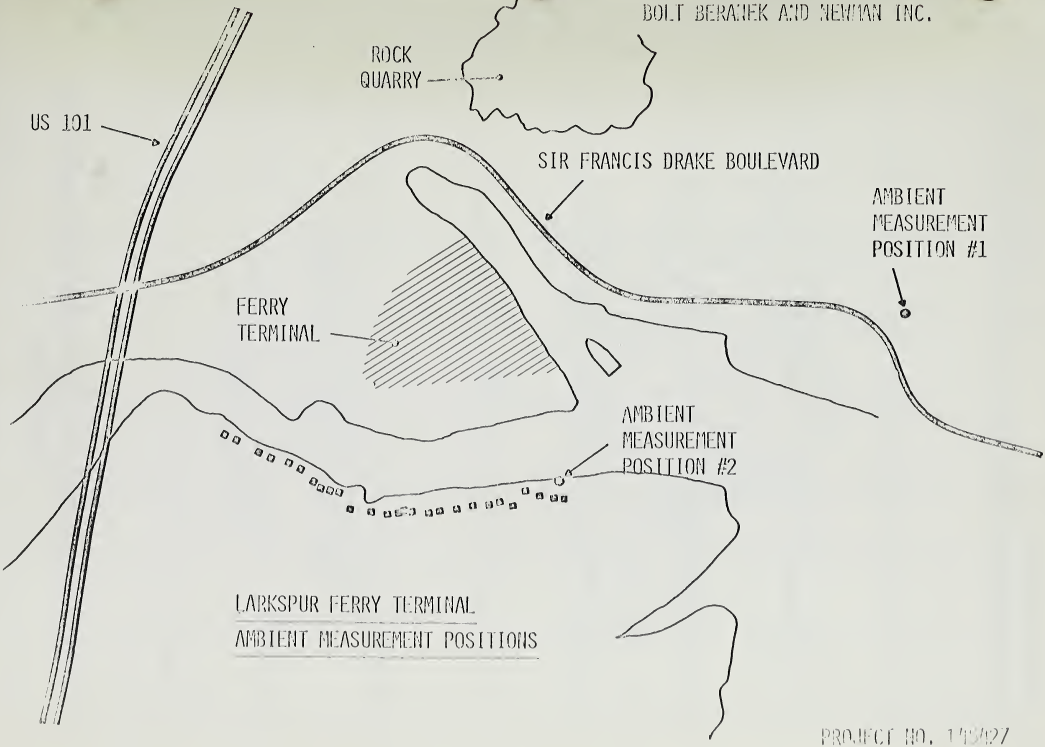
Joel A. Lewitz

JAL:n

cc: Addressee

enc:

BOLT BERANEK AND NEWMAN INC.



LARKSPUR FERRY TERMINAL

AMBIENT MEASUREMENT POSITIONS

PROJECT NO. [illegible]
JUNE 21, 1975
FIGURE 1

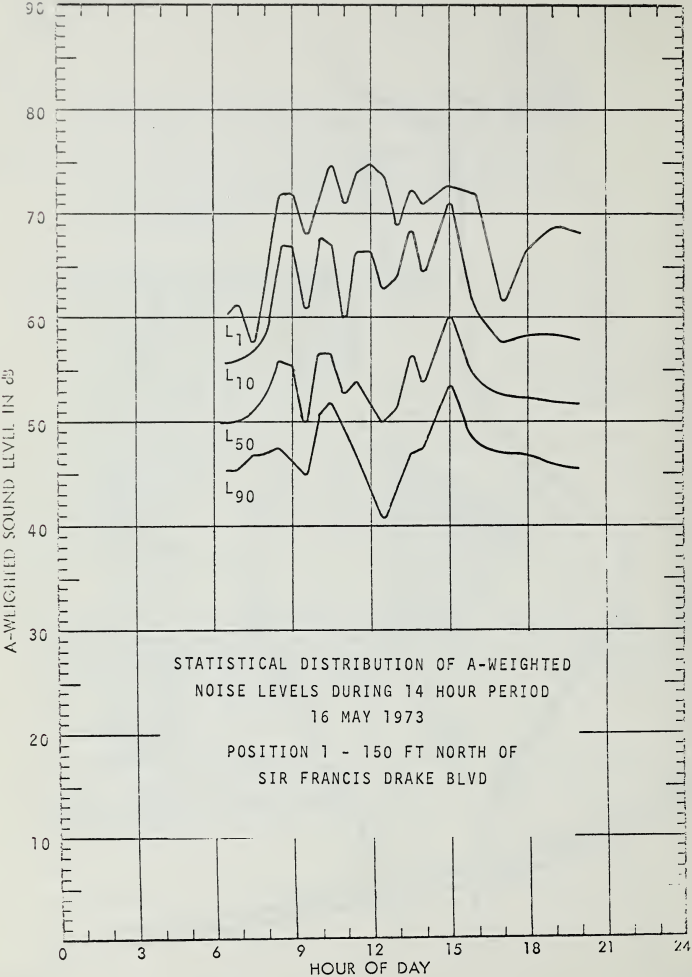
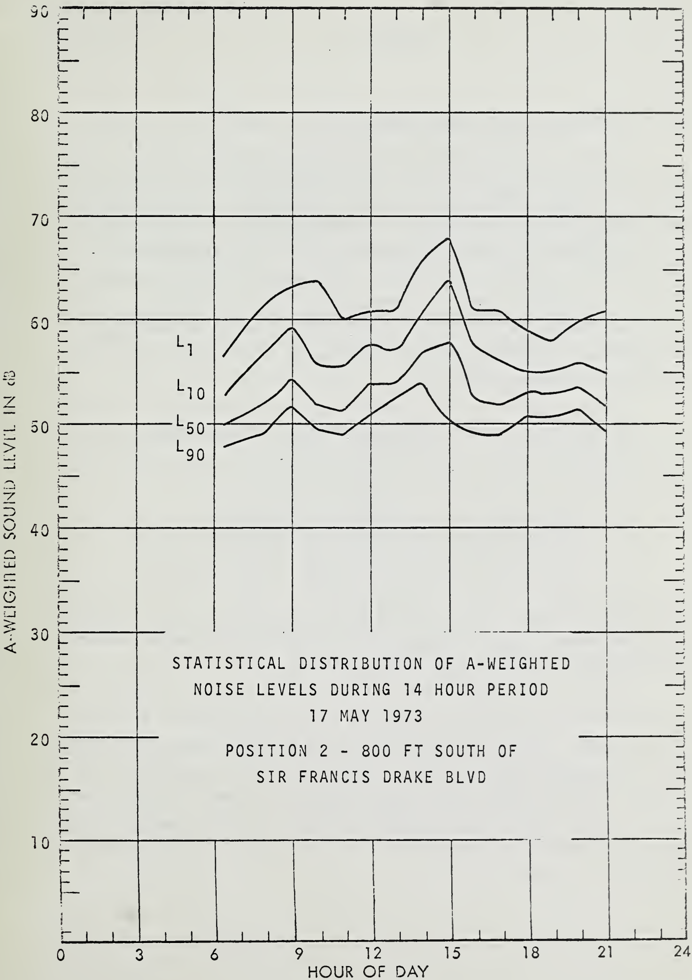

90
80
70
60
50
40
30
20
10
A-WEIGHTED SOUND LEVEL IN dB
L_1
L_{10}
L_{50}
L_{90}
STATISTICAL DISTRIBUTION OF A-WEIGHTED
NOISE LEVELS DURING 14 HOUR PERIOD
16 MAY 1973
POSITION 1 - 150 FT NORTH OF
SIR FRANCIS DRAKE BLVD
0
3
6
9
12
15
18
21
24
HOUR OF DAY

FIGURE 2



STATISTICAL DISTRIBUTION OF A-WEIGHTED NOISE LEVELS DURING 14 HOUR PERIOD
17 MAY 1973

POSITION 2 - 800 FT SOUTH OF SIR FRANCIS DRAKE BLVD

FIGURE 3

APPENDIX I

ENVIRONMENTAL NOISE DESCRIPTORS

The term environmental noise denotes the noise climate within which a person lives, eats, sleeps and works. As he moves between his home and place of work and places of relaxation and entertainment, the noise environment that he experiences is continually changing. As long as the environment in each place lies within certain prescribed limits to which a person is accustomed, and as long as this environment accommodates his needs to communicate, to listen, to sleep, etc., he will usually be content with it.

A scheme for predicting the effect that a noise might have on human response, i.e. the impact of noise, must, in some way, account for each of the following parameters.

+ The intensity or level of the sound
+ The frequency spectrum of the sound
+ The time-varying character of the sound

For impact due to the Ferry Terminal operations, the intensity and frequency of the sound can be quantified in terms of the "A-weighted" sound level (dBA).

An increase of 10 dBA corresponds to an approximate doubling of loudness. The A-weighted sound level descriminates against low frequency sound to which the ear is least sensitive and emphasizes the middle and high frequency sounds to which the ear is most sensitive. In past studies, the A-weighted level has been found to correlate well with subjective acceptability ratings of noise.

The A-level in decibels is expressed "dBA;" the appended letter "A" is a reminder of the particular kind of weighting used for the measurement. In practice, the A-level of a sound source is conveniently measured using a sound level meter that includes an electrical filter corresponding to the A-weighting curve. All US and international standard sound level meters include such a filter.

Although the A-level may adequately describe environmental noise at any instant in time, the fact is that the community noise level varies continuously. Most environmental noise includes a conglomeration of distant noise sources which creates a relatively steady background noise in which no particular source is identifiable. These distant sources may include traffic, wind in trees, industrial or farming activities, etc. These noise sources are relatively constant from moment-to-moment, but vary slowly from hour-to-hour as natural forces change or as human activity follows its daily cycle. Superimposed on this slowly-varying background is a succession of identifiable noisy events of brief duration. These may include nearby activities or single vehicle passages, aircraft flyovers, etc., which cause the environmental noise level to vary from instant-to-instant.

In our letter as has become standard practice, the time varying character of environmental sound is accounted for statistically. The statistical descriptor used in this letter is the A-level that is exceeded 10% of the time,

designated by the symbol "L_{10}." L_{10} is considered a good measure of "average peak" noise. Close to a highway, where noise levels vary from moment-to-moment, human response probably relates more to the noise peaks, such as from individual vehicle passages, rather than to the median sound level, L_{50}, the A-level that is exceeded 50% of the time. At the other end of the statistical scale is L_{90}, the A-level exceeded 90% of the time. This is considered a good measure of the background noise at a site.

APPENDIX II

MEASUREMENT PROGRAM

On 16 and 17 May 1973, we conducted an ambient noise measurement program at the Larkspur Ferry Terminal site. These measurements consisted of a 14 hour sampling of the A-weighted sound levels at each of two positions as shown on Figure 1. The measurements were taken between the hours of 6:00am and 8:00pm corresponding to the hours of the terminal operation.

The measurement program instrumentation consisted of a Bruel & Kjaer model 2203 precision sound level meter and a Bruel & Kjaer model 4131 condenser microphone fitted with a random incidence corrector and a windscreen. The data was recorded on a Uher model 4200 tape recorder specially modified by BBN with a timer to record two seconds of data every 20 seconds. This micro-sampling technique greatly reduces data reduction time without altering the statistical picture of the noise levels.

The taped data was analyzed statistically in our laboratory using a Bruel & Kjaer model 2112 audio frequency spectrometer, a Bruel & Kjaer model 2305 graphic level recorder and a Bruel & Kjaer model 4420 statistical distribution analyzer. The output from the statistical distribution analyzer was fed to an IBM 360-65 computer using a BBN program to calculate the actual statistical levels plotted on Figures 2 and 3.

Appendix G

Air Quality Impact Study

July 5, 1973

by

Joseph D. Coons
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5 July 1973

GOLDEN GATE BRIDGE DISTRICT
LARKSPUR FERRY TERMINAL
AIR QUALITY IMPACT STUDY

PURPOSE AND SCOPE

This study assesses the probable impact on air quality of the proposed Larkspur Ferry Terminal in Marin County, California, as compared to the alternative course of providing no ferry service. Study year for the assessment was 1990.

With respect to air quality, the primary influence of the terminal would be in its effects on vehicular traffic. Some commuters, and off-peak travelers, would take the ferry from Larkspur rather than drive into San Francisco and return. Their trip origins would be from Novato, or northward, to as far south as Corte Madera; some would drive to the terminal and park there, others would take buses from their residence areas. For ferry passengers, the ferry trip would totally replace the round-trip to and from San Francisco by automobile; for many of them, bus travel would replace the round trip from residence to terminal and return. The benefits, or disadvantages, to air quality lie in the changes in emissions through reduction in auto travel and increase in bus and ferry operations; these are the operations which have been compared under the alternates of providing, or not providing, such ferry service.

Contaminants considered included carbon monoxide, nitrogen oxides, hydrocarbons, particulate matter, and sulfur oxides. For autos and buses, emission factors (in grams per vehicle mile) were developed for 1973 and 1990 according to an adaptation of proposed federal (EPA) methods,[1] including

correction for average speeds, control deterioration, vehicle age-mix (adapted from Bay Area APCD information[2]) and utilization factors, and control effectiveness experienced or predicted under presently adopted requirements. For ferry operation, emission factors were developed in grams per operating hour and per trip, although data were far less satisfactory for this development.

Of primary concern in the study was the effect of any changes in traffic at the interchange linking Sir Francis Drake Boulevard to U.S. Highway 101. This interchange will be used by essentially all traffic, both auto and bus, serving the terminal; and it was not apparent at the outset whether the terminal would increase or alleviate congestion at this interchange. For this reason, a primary study area was defined, to include both the freeway and Sir Francis Drake in an area bounded by a circle of one-half mile radius, centered at the interchange. Although numerous other potential developments prevent firm projections of 1990 traffic volume and flow at this interchange, a representative base pattern was establihsed, and deviations due to ferry terminal operation were examined in considerable detail, both as to volume and average speed. Reductions in passenger vehicle emissions were credited to the terminal operation; increases in such emissions were debited, as were bus and ferry emissions. The results of these projections, with 1973 estimates for comparison, are presented in Table 1.

For the entire region, including the study area, there are the additional impacts of reduced vehicular traffic, both north and south of the study area, as commuters change to the ferry; of increased bus traffic for passenger pickup; and of increased emissions due to the ferry travel from the study area to San Francisco and return. Because substantial and highly variable (in projection) increments of traffic join

traffic southbound from the terminal, and leave northbound traffic to the terminal, no attempt has been made to project total traffic, and total emissions, on an area-wide basis; such an effort would involve, in addition, significant and uncertain projections as to population growth, distribution and activity in the entire southern portion of the county. This omission, of course, prevents extrapolation of the changes in emission rates developed here into projections of changes in air quality levels on a regional basis. Since the changes are extremely small, however, in relation to total area emission rates, such air quality projections would be highly questionable in any case.

The reductions in daily emission rates (in pounds per day) are shown in Table 2, for both the primary study area and the entire area affected.

CONCLUSIONS

1. The net effect of the ferry and terminal operations, as projected for 1990, is to reduce the emission rate of each of the contaminants considered, both in the very small interchange area and in the total county and regional areas. Increases due to bus and ferry operations are more than offset by decreases due to reduced automobile travel. (If the higher of the two sulfur-content ranges in fuel, suggested by the manufacturer, is used in the ferry, some very small increase in sulfur oxides could result, rather than the indicated small decrease.)
2. Within the primary study area, and generally for all automobile traffic, reductions due to improved emission controls between 1973 and 1990 are far more significant than the differences between the two 1990 alternates evaluated, except in the case of sulfur dioxide. (No controls are

presently proposed for vehicular emissions of sulfur oxides, which are governed by the sulfur content of the fuel; the study area generally shows "zero" to "trace" levels of sulfur dioxide, in any case.[3,4])

3. Within the primary study area, vehicular emissions comprise essentially all of the emissions from all sources; thus the projected decreases in emission rates can reasonably be taken as projections of similar proportional decreases in air quality levels.[4] Thus the projections show a beneficial effect on air quality levels within the primary study area, and regionally, for every contaminant; these beneficial impacts, however, are not highly significant even in the small study area, being on the order of 1% to 7%. On a regional basis, the inclusion of larger traffic volumes not reduced by the ferry terminal alternate, as well as many non-vehicular sources, reduces the significance still further.

4. No change in vegetative effects on air quality appears to be involved in the evaluation of these alternates. In the highly vegetated area involved, the small proportion of vegetation lost by terminal facilities construction cannot be of great significance, either positive or negative, to air quality. Vegetation is both a source of air contaminants and a receiver or sink for contaminants; quantitative information as to the relative value of specific types of vegetation for specific contaminants is not adequate, at present, for any realistic assessment.

5. The proposed terminal is not a growth-inducing project per se; to the extent it alleviates traffic and other present problems, it might be deemed to permit growth, if people will accept, and planning will permit, additional growth to re-establish present levels of such problems.

Table 1. Comparison of Emission Rates (lb/day) in Study Area.*

Contaminant	1973 Estimates	1990 Projections With Ferry	1990 Projections No Ferry
Carbon Monoxide	8,764	2,105	2,126
Nitrogen Oxides	2,033	485	515
Hydrocarbons	6,640	2,287	2,462
Particulate Matter	100	38	41
Sulfur Oxides	60	72	73

* Primary study area, to which these figures apply, was a circle of one-half mile radius, centered on the interchange at Sir Francis Drake Boulevard and U.S. 101.

Table 2. Projected Reductions (lb/day) in 1990 through Ferry Operations.

Contaminant	Primary Study Area	Bay Area Region
Carbon Monoxide	21	168
Nitrogen Oxides	30	353
Hydrocarbons	175	2,048
Particulate Matter	3	38
Sulfur Oxides	1*	28*

* Based on sulfur content of 0.075% in fuel; some increase (rather than reduction) might be found if higher-sulfur fuel is used.

REFERENCES

1. D. S. Kircher, D. P. Armstrong, "An Interim Report on Motor Vehicle Emission Estimation" Environmental Protection Agency (revised January 1973).

2. Bay Area APCD, "1971 Source Inventory", 939 Ellis St., San Francisco, California (1972).

3. Bay Area APCD, "Contaminant and Weather Summary", published monthly.

4. R. H. Thuillier, "Air Quality Statistics in Land Use Planning Applications", Third Conf. on Prob. and Stat. in Atmoshperic Sci., Boulder Colo. (June 1973).

APPENDIX: SUMMARY OF TRAFFIC AND VEHICULAR EMISSION DATA

The following 11 tables present analyses of vehicular miles travelled and emission, identified by case numbers. The last three digits of these numbers indicate the applicability of the data, as follows:

001: 1973, AM peak hour
002: PM peak hour
003: balance of day

011: 1990, AM peak hour, no ferry terminal
012: PM peak hour
013: balance of day

111: 1990, AM peak hour, with terminal
112: PM peak hour
113: balance of day

114: 1990, with terminal, auto deletion & bus addition, peak
116: same, for 22 hours excluding AM & PM peak hours

In the first 9 tables (001-113), "Link" numbers identify specific portions of Sir Francis Drake and U.S. 101 within the half-mile radius of the study area; as might be inferred from the small total mileage (5.7 miles), most of these links consist of very short individual sections of the interchange. A sketch of the interchange is attached following the tables.

The last two tables (114-116) show reductions in traffic and emissions; negative numbers indicate increases, as where buses are added to heavy-duty traffic; similarly, emission figures are to be subtracted (if positive in the tables) from the prior emission data.

In the first six tables (001-013), heavy-duty vehicles are taken as 5% of the total traffic; in the next three (111-113), the heavy-duty count includes not only 5% of the total non-terminal traffic, but an additional number of buses as projected for transfer of ferry passengers.

Because the size of final emission figures is not always apparent until computed, these figures are printed in grams, pounds, and tons, rounded to the nearest whole number, with two exceptions: Numbers which are 1,000,000 or greater are shown only as exceeding 1,000,000; and numbers below 0.5 are not shown.

VEHICULAR EMISSIONS (Tons/yr) STUDY YEAR 1973 CASE 064-23-001

LINK	MILES	MPH	LT DUTY VEH CT	LT DUTY VM/D	HY DUTY VEH CT	HY DUTY VM/D
100	0.184	47	5890	1084	310	57
101	0.304	60	3420	1040	180	55
102	0.525	45	5510	2893	290	152
103	0.370	60	3040	1125	160	59
104	0.300	42	6650	1995	350	105
105	0.323	60	4275	1381	225	73
106	0.374	35	1615	604	85	32
107	0.084	35	1140	96	60	5
108	0.108	35	1377	149	73	8
109	0.080	45	1235	99	65	5
110	0.220	35	855	188	45	10
111	0.084	30	1187	100	63	5
112	0.336	35	1235	415	65	22
113	0.233	40	380	89	20	5
114	0.128	35	332	42	18	2
115	0.109	30	475	52	25	3
116	0.090	26	570	51	30	3
117	0.204	30	570	116	30	6
118	0.384	35	570	219	30	12
119	0.384	35	380	146	20	8
120	0.204	30	380	78	20	4
121	0.090	30	380	34	20	2
122	0.092	30	47	4	3	
123	0.087	30	237	21	13	1
124	0.132	30	380	50	20	3
125	0.137	30	380	52	20	3
126	0.117	20	95	11	5	1
TOTALS	5.683			12132		639

	CO	NO_x	HC	PARTIC	SO_x
grams	374493	72309	255874	3831	2299
pounds	826	159	564	8	5
tons					

VEHICULAR EMISSIONS (Tons/yr)   STUDY YEAR 1973   CASE 064-23-002

LINK	MILES	MPH	LT DUTY VEH CT	LT DUTY VM/D	HY DUTY VEH CT	HY DUTY VM/D
100	0.184	60	3543	652	187	34
101	0.304	50	5681	1727	299	91
102	0.525	60	3040	1596	160	84
103	0.370	45	5225	1933	275	102
104	0.300	60	4275	1283	225	68
105	0.323	42	6650	2148	350	113
106	0.374	35	1235	462	65	24
107	0.084	35	855	72	45	4
108	0.108	41	1235	133	65	7
109	0.080	40	1425	114	75	6
110	0.220	35	1140	251	60	13
111	0.084	30	1520	128	80	7
112	0.336	30	1615	543	85	29
113	0.233	40	503	117	27	6
114	0.128	35	380	49	20	3
115	0.109	30	380	41	20	2
116	0.090	26	456	41	24	2
117	0.204	30	380	78	20	4
118	0.384	35	380	146	20	8
119	0.384	35	570	219	30	12
120	0.204	30	570	116	30	6
121	0.090	30	475	43	25	2
122	0.092	30	95	9	5	
123	0.087	30	380	33	20	2
124	0.132	30	285	38	15	2
125	0.137	30	456	62	24	3
126	0.117	20	76	9	4	
TOTALS	5.683			12041		634

	CO	NO_x	HC	PARTIC	SO_x
grams	371808	71926	253950	3803	2282
pounds	820	159	560	8	5
tons					

VEHICULAR EMISSIONS (Tons/yr) STUDY YEAR 1973 CASE 064-23-003

			LT DUTY		HY DUTY	
LINK	MILES	MPH	VEH CT	VM/D	VEH CT	VM/D
100	0.184	60	47566	8752	2504	461
101	0.304	60	47899	14561	2521	766
102	0.525	60	43700	22943	2300	1208
103	0.370	60	43985	16274	2315	857
104	0.300	60	55575	16673	2925	878
105	0.323	60	55575	17951	2925	945
106	0.374	35	13300	4974	700	262
107	0.084	40	9405	790	495	42
108	0.108	45	11637	1257	613	66
109	0.080	50	11590	927	610	49
110	0.220	40	9405	2069	495	109
111	0.084	35	12492	1049	658	55
112	0.336	35	13300	4469	700	235
113	0.233	40	3866	901	204	48
114	0.128	35	3087	395	163	21
115	0.109	30	3895	425	205	22
116	0.090	30	4075	367	215	19
117	0.204	30	3800	775	200	41
118	0.384	35	3800	1459	200	77
119	0.384	35	3800	1459	200	77
120	0.204	30	3800	775	200	41
121	0.090	30	2945	265	155	14
122	0.092	30	807	74	43	4
123	0.087	30	2232	194	118	10
124	0.132	30	2185	288	115	15
125	0.137	40	3914	536	206	28
126	0.117	30	779	91	41	5
TOTALS	5.683			120694		6353

	CO	NO_x	HC	PARTIC	SO_x
grams	(10^6 +)	777971	(10^6 +)	38114	22868
pounds	7118	1715	5516	84	50
tons	4	1	3		

VEHICULAR EMISSIONS (Tons/yr) STUDY YEAR 1990 CASE 064-23-011

LINK	MILES	MPH	LT DUTY VEH CT	LT DUTY VM/D	HY DUTY VEH CT	HY DUTY VM/D
100	0.184	54	5168	951	272	50
101	0.304	47	5909	1796	311	95
102	0.525	40	4408	2314	232	122
103	0.370	45	4389	1624	231	85
104	0.300	35	7733	2320	407	122
105	0.323	44	6289	2031	331	107
106	0.374	30	3040	1137	160	60
107	0.084	28	2375	200	125	11
108	0.108	26	3325	359	175	19
109	0.080	36	1900	152	100	8
110	0.220	35	1425	314	75	17
111	0.084	30	1805	152	95	8
112	0.336	32	2470	830	130	44
113	0.233	40	760	177	40	9
114	0.128	34	380	49	20	3
115	0.109	30	665	72	35	4
116	0.090	26	1045	94	55	5
117	0.204	30	950	194	50	10
118	0.384	35	950	365	50	19
119	0.384	31	2565	985	135	52
120	0.204	30	2565	523	135	28
121	0.090	30	1615	145	85	8
122	0.092	30	665	61	35	3
123	0.087	30	950	83	50	4
124	0.132	30	475	63	25	3
125	0.137	30	1520	208	80	11
126	0.117	20	380	44	20	2
TOTALS	5.633			17243		908

	CO	NO_x	HC	PARTIC	SO_x
grams	112099	20962	111503	1815	3267
pounds	247	46	246	4	7
tons					

VEHICULAR EMISSIONS (Tons/yr) STUDY YEAR 1990 CASE 064-23-012

			LT DUTY		HV DUTY	
LINK	MILES	MPH	VEH CT	VM/D	VEH CT	VM/D
100	0.184	47	5909	1087	311	57
101	0.304	40	5168	1571	272	83
102	0.525	45	4389	2304	231	121
103	0.370	38	4408	1631	232	86
104	0.300	44	6289	1887	331	99
105	0.323	35	7733	2498	407	131
106	0.374	32	2470	924	130	49
107	0.084	34	1425	120	75	6
108	0.108	36	1900	205	100	11
109	0.080	26	3325	266	175	14
110	0.220	30	2375	523	125	28
111	0.084	29	2945	247	155	13
112	0.336	32	3040	1021	160	54
113	0.233	35	1520	354	80	19
114	0.128	32	570	73	30	4
115	0.109	30	1045	114	55	6
116	0.090	26	1995	180	105	9
117	0.204	30	2565	523	135	28
118	0.384	31	2565	985	135	52
119	0.384	35	950	365	50	19
120	0.204	30	950	194	50	10
121	0.090	30	570	51	30	3
122	0.092	30	95	9	5	
123	0.087	30	475	41	25	2
124	0.132	30	950	125	50	7
125	0.137	30	760	104	40	5
126	0.117	20	950	111	50	6
TOTALS	5.683			17513		922

	CO	NO_x	HC	PARTIC	SO_x
grams	116231	21022	113439	1844	3318
pounds	256	46	250	4	7
tons					

VEHICULAR EMISSIONS (Tons/yr) STUDY YEAR 1990 CASE 064-23-C13

LINK	MILES	MPH	LT DUTY VEH CT	LT DUTY VM/D	HY DUTY VEH CT	HY DUTY VM/D
100	0.184	60	45258	8327	2382	438
101	0.304	60	45258	13758	2382	724
102	0.525	60	35188	18474	1852	972
103	0.370	60	35188	13020	1852	685
104	0.300	60	56088	16826	2952	886
105	0.323	60	56088	18116	2952	953
106	0.374	35	22040	8243	1160	434
107	0.084	40	14725	1237	775	65
108	0.108	45	20900	2257	1100	119
109	0.080	50	20900	1672	1100	88
110	0.220	40	14725	3240	775	171
111	0.084	35	19475	1636	1025	86
112	0.336	35	22040	7405	1160	390
113	0.233	40	10070	2346	530	123
114	0.128	35	4750	608	250	32
115	0.109	30	7315	797	385	42
116	0.090	30	12635	1137	665	60
117	0.204	30	14060	2868	740	151
118	0.384	35	14060	5399	740	284
119	0.384	35	14060	5399	740	284
120	0.204	30	14060	2868	740	151
121	0.090	30	8740	787	460	41
122	0.092	30	2565	236	135	12
123	0.087	30	6175	537	325	28
124	0.132	30	6175	815	325	43
125	0.137	40	10070	1380	530	73
126	0.117	30	5320	622	280	33
TOTALS	5.683			140012		7369

	CO	NO_x	HC	PARTIC	SO_x
grams	736082	192087	891576	14738	26529
pounds	1623	423	1966	32	58
tons	1		1		

VEHICULAR EMISSIONS (Tons/yr) STUDY YEAR 1990 CASE 064-23-111

LINK	MILES	MPH	LT DUTY VEH CT	LT DUTY VM/D	HY DUTY VEH CT	HY DUTY VM/D
100	0.184	60	3765	693	262	48
101	0.304	47	5909	1796	375	114
102	0.525	58	2340	1229	123	65
103	0.370	45	4389	1624	231	85
104	0.300	56	4954	1486	266	80
105	0.323	44	6346	2050	339	109
106	0.374	32	2557	956	157	59
107	0.084	32	1664	140	88	7
108	0.108	31	2614	282	143	15
109	0.080	36	1957	157	105	9
110	0.220	35	1425	314	75	17
111	0.084	30	1805	152	95	8
112	0.336	32	2470	830	152	51
113	0.233	40	1425	332	139	32
114	0.128	34	380	49	20	3
115	0.109	30	893	97	69	8
116	0.090	26	1938	174	188	17
117	0.204	30	1900	388	191	39
118	0.384	35	950	365	50	19
119	0.384	31	2565	985	135	52
120	0.204	30	2565	523	226	46
121	0.090	30	1615	145	112	10
122	0.092	30	665	61	57	5
123	0.087	30	950	83	55	5
124	0.132	30	532	70	33	4
125	0.137	30	1520	208	144	20
126	0.117	20	1045	122	119	14
TOTALS	5.683			15310		941

	CO	NO_x	HC	PARTIC	SO_x
grams	104318	19893	99823	1625	2925
pounds	230	44	220	4	6
tons					

VEHICULAR EMISSIONS (Tons/yr) STUDY YEAR 1990 CASE 064-23-112

LINK	MILES	MPH	LT DUTY VEH CT	LT DUTY VM/D	HY DUTY VEH CT	HY DUTY VM/D
100	0.184	47	5909	1087	375	69
101	0.304	60	3765	1145	262	80
102	0.525	45	4389	2304	231	121
103	0.370	58	2340	866	123	46
104	0.300	44	6346	1904	339	102
105	0.323	56	4954	1600	266	86
106	0.374	32	2470	924	152	57
107	0.084	34	1425	120	75	6
108	0.108	36	1957	211	108	12
109	0.080	30	2614	209	143	11
110	0.220	34	1664	366	88	19
111	0.084	33	2234	188	118	10
112	0.336	32	2557	859	157	53
113	0.233	35	1520	354	144	34
114	0.128	32	570	73	30	4
115	0.109	30	1045	114	77	8
116	0.090	26	1995	180	191	17
117	0.204	30	2565	523	226	46
118	0.384	31	2565	985	135	52
119	0.384	35	950	365	50	19
120	0.204	30	1900	388	191	39
121	0.090	30	855	77	72	6
122	0.092	30	323	30	39	4
123	0.087	30	532	46	33	3
124	0.132	30	950	125	55	7
125	0.137	30	1425	195	139	19
126	0.117	20	950	111	114	13
TOTALS	5.683			15349		943

	CO	NO_x	HC	PARTIC	SO_x
grams	104521	19957	100065	1629	2932
pounds	230	44	221	4	6
tons					

VEHICULAR EMISSIONS (Tons/yr)   STUDY YEAR 1990   CASE 064-23-113

			LT DUTY		HY DUTY	
LINK	MILES	MPH	VEH CT	VM/D	VEH CT	VM/D
100	0.184	60	42269	7777	2328	428
101	0.304	60	42269	12850	2328	708
102	0.525	60	29799	15644	1568	823
103	0.370	60	29799	11026	1568	580
104	0.300	60	51658	15497	2728	818
105	0.323	60	51658	16686	2728	881
106	0.374	35	21017	7860	1141	427
107	0.084	40	13588	1141	715	60
108	0.108	45	19791	2137	1051	114
109	0.080	50	19791	1583	1051	84
110	0.220	40	13588	2989	715	157
111	0.084	35	18338	1540	965	81
112	0.336	35	21017	7062	1141	383
113	0.233	40	10402	2424	651	152
114	0.128	35	4750	608	250	32
115	0.109	30	7429	810	426	46
116	0.090	30	13081	1177	827	74
117	0.204	30	14535	2965	912	186
118	0.384	35	14060	5399	740	284
119	0.384	35	14060	5399	740	284
120	0.204	30	14535	2965	912	186
121	0.090	30	8882	799	512	46
122	0.092	30	2679	246	176	16
123	0.087	30	6203	540	336	29
124	0.132	30	6203	819	336	44
125	0.137	40	10402	1425	651	89
126	0.117	30	5652	661	401	47
TOTALS	5.683			130032		7062

	CO	NO_x	HC	PARTIC	SO_x
grams	706635	178450	830614	13709	24677
pounds	1558	393	1831	30	54
tons	1		1		

VEHICULAR EMISSIONS (Tons/yr) STUDY YEAR 1990 CASE 064-23-114

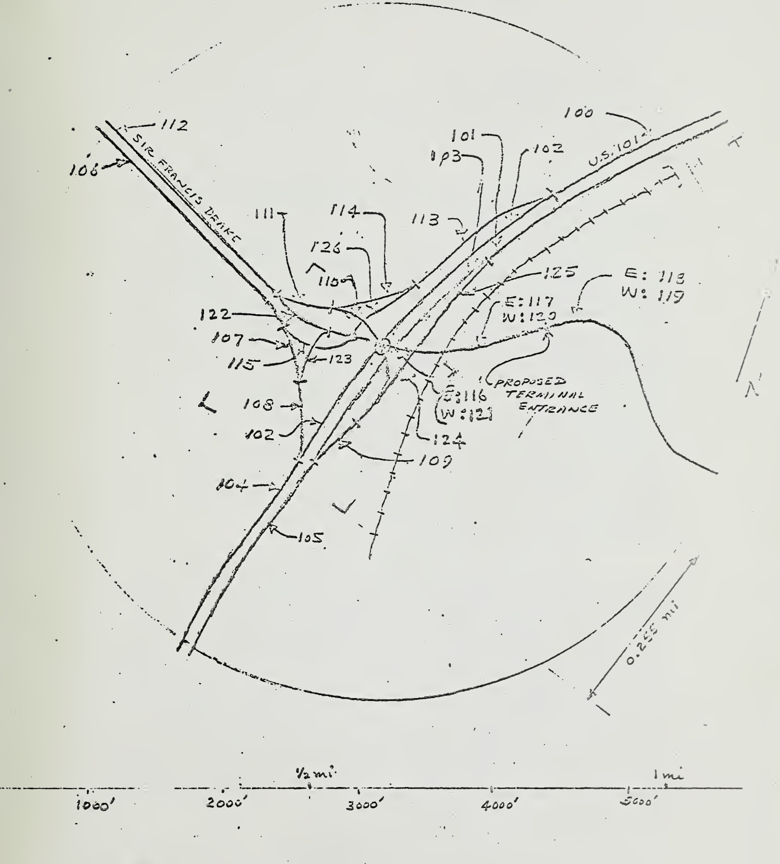
LINK	MILES	MPH	LT DUTY VEH CT	LT DUTY VM/D	HY DUTY VEH CT	HY DUTY VM/D
100	1.500	55	115	173	-5	-8
101	4.500	55	208	936	-9	-41
102	2.500	55	92	230	-4	-10
103	1.000	55	208	208	-9	-9
104	2.000	55	738	1476	-32	-64
105	4.500	55	208	936	-9	-41
106	6.000	55	208	1248	-9	-54
107	9.000	55	323	2907	-14	-126
TOTALS	31.000			8114		-352

	CO	NO_x	HC	PARTIC	SO_x
grams	-1918	7669	44795	776	1397
pounds	-4	17	99	2	3
tons					

VEHICULAR EMISSIONS (Tons/yr) STUDY YEAR 1990 CASE 064-23-116

LINK	MILES	MPH	LT DUTY VEH CT	LT DUTY VM/D	HY DUTY VEH CT	HY DUTY VM/D
100	1.534	55	277	425	-9	-14
101	4.500	55	461	2075	-15	-68
102	2.500	55	185	463	-6	-15
103	1.000	55	431	431	-14	-14
104	2.000	55	1577	3154	-52	-104
105	4.500	55	461	2075	-15	-68
106	6.000	55	431	2586	-14	-84
107	9.000	55	677	6093	-22	-198
TOTALS	31.034			17300		-564

	CO	NO_x	HC	PARTIC	SO_x
grams	5426	17274	97069	1674	3013
pounds	12	38	214	4	7
tons					



SIR FRANCIS DRAKE
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1000'
2000'
3000'
4000'
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JOSEPH D. COONS
CONSULTING ENGINEER
853 PATRICIA
SAN RAFAEL, CALIFORNIA 94903
(415) 479-4130

6 July 1973

Mr. Frank Boerger
Madrone Associates, Inc.
P. O. Box 2970
San Rafael, California 94901

Dear Frank:

This will confirm our discussion of today in regard to the proposed Ferry Terminal, and my study of air quality impact.

Primary attention was given in my study to the Larkspur site, and detailed analysis centered on the interchange at Sir Francis Drake and Highway 101 which would have the major traffic involvement. For the San Quentin North site, the interchange involved would be that of Highways 17 and 101. Both of these interchanges present some design problems for an increase in traffic from 101 to and from the proposed sites, and I have assumed that some degree of reconstruction (short of total redesign) would be provided to accommodate this increased traffic. With this proviso, I find no substantial difference in air quality impact of the two sites. In both cases, the major conclusions are (a) that ferry operation is of benefit to air quality levels of all considered contaminants; and (b) that the difference is too small to be a major determinant in decisions.

Emissions from ferry engines have been estimated, and are included in the figures presented in Tables 1 and 2. The ferry engine emission estimates are not as firm as might be desired, due to lack of some data and apparent inconsistencies in reported emission factors supplied by the manufacturer; they are of the right order of magnitude, however, insofar as I can judge, and greater accuracy does not appear to be required to allow firm conclusions. Ferry emissions are significant fractions of projected reductions of vehicular emissions, for some contaminants, and it would therefore be misleading to ignore them entirely; however, they are not of such magnitude as to be significant in total emission loads or in resultant air quality.

Sincerely,

J. D. Coons

<u>The Potential Impact of the Larkspur Ferry Terminal Development on Climate and Air Pollution (Microclimate)</u>

by

Albert Miller

Consulting Meteorologist

June 11, 1973

Table of Contents

1. The potential impact on climate

There are two principal ways in which a development might affect the climate and "air quality" of an area:

(a) Changes in the existing characteristics of the earth's surface affect the exchange of heat and momentum between it and the air above it. Both the temperature and movement of air are largely determined by the underlying surface, particularly in the lowest 50 feet of the atmosphere.

(b) Pollutants and heat injected into the air are, in themselves, climatic changes; they may induce further change by interfering with the natural heat exchange processes. In addition, of course, pollutants are themselves considered to be harmful air constituents.

This report considers the influence of the proposed development on the atmospheric environment brought about by (a) changes in the physical properties of the ground surface and (b) emissions of pollutants and heat into the air. It should be stressed that this is not a "research report", but an appraisal of the effects, based on existing climatological and air pollution data. The evaluation of this development's effect on climate and smog is stated as a function of distance from the development, since the potential magnitude of the impact depends on the size of the development relative to the size of the affected area being considered. A one square mile

development may produce a significant overall change within a mile or two distance but the climatic change may be undetectable over an area of 100 square miles. Similarly, the air pollution contribution of a single factory or automobile may be undetectable when diluted by the atmosphere over an entire county but is noticeable close to the source when atmospheric conditions are right.

2. The land use plan

According to data supplied by Madrone Associates, the development will have the following characteristics which are pertinent to this report:

(a) Surface changes

The proposed Larkspur ferry terminal is located about 3 miles south of San Rafael in Marin County, between Corte Madera Creek and Sir Francis Drake Boulevard. The land area to be occupied by the terminal complex (about 18 acres) is low (5-10 ft. elevation), flat, and barren; over half (about 10 acres) will be used for parking (roads and parking lot paved with asphalt concrete over base rock) and the remainder by buildings (ferry terminal and commercial) and access roads. The adjacent barge channel (next to Sir Francis Drake Blvd.) will be dredged and a small island (maximum width of 200', length of about 500')

will be eliminated to permit access to the harbor. It is estimated that clearing of the channel will add 5 or 6 acres of new water surface, most to a depth of 12 feet.

(b) Emissions into the atmosphere

Since no industries are planned for the development the only heat generation will be that used for space heating. This latter is typically very small in the San Francisco Bay Area and can be neglected. Commercial developments do not typically produce significant quantities of gaseous or particulate pollution. Thus, in this case, only pollutants generated by automotive and ferry traffic need be considered.

Automotive traffic estimates for the years 1975 and 1990 for both that generated by the ferry terminal and other traffic along the adjacent highway (Sir Francis Drake Boulevard) not related to the terminal, are shown in Table 1. Various estimates of traffic were gleaned from reports by Madrone Associates, Kaiser Engineers, the Bridge District, and the Marin County Public Works Department. For the purposes of this report, the highest traffic estimates have been used, so that computed pollution levels will be on the pessimistic side.

The estimated source strength of carbon monoxide will be used to determine the effect of the development on the pollutant levels in the environment. Other species (such

Table 1. Carbon Monoxide Emissions from Automobile Traffic Generated by Larkspur Terminal and on Adjacent Highway.

Source	Year	Normal Daily (weekday)			Normal Peak Hour (weekday)		
		a	b	c	a	b	c
1. Within terminal	1975	7,000	1.33 (1.60)	0.20 (0.24)	1200	4.10 (4.92)	0.63 (0.76)
	1990	9,000	1.71 (2.05)	0.26 (0.31)	1500	5.12 (6.14)	0.79 (0.95)
2. Sir Francis Drake Blvd., not related to terminal	1975	6,000	0.89 (2.31)	0.14 (0.36)	1000	2.63 (6.84)	0.42 (1.09)
	1990	22,000	3.22 (8.37)	0.52 (1.35)	3700	9.73 (25.30)	1.56 (4.06)
3. Sir Francis Drake Blvd., all traffic (total of 1 & 2)	1975	13,000	1.90 (4.94)	0.30 (0.78)	2200	5.79 (15.05)	0.93 (2.42)
	1990	31,000	4.53 (11.78)	0.72 (1.87)	5200	13.68 (35.57)	2.19 (5.69)

a: Estimated number of vehicles (per day or per hour).

b: Source strength, mg/ft/sec, based on current (1972) emission rates of 65 grams/mile for terminal traffic and 50 grams/mile for highway traffic.
( ) = Total emission rate, grams/sec.

c: Source strength, mg/ft/sec, based on projected emission standards of 10 grams/mile for terminal traffic and 8 grams/mile for highway traffic.
( ) = Total emission rate, grams/sec.

as hydrocarbons and oxides of nitrogen) should be generated at proportionate rates and the concentrations of these other contaminants will fall off with distance at about the same rate as carbon monoxide. (Except for lead, which tends to decrease more rapidly with distance.) The carbon monoxide source strengths given in Table 1 are based on the average emission rates for motor vehicles in 1972 and the projected emission rates in 1990 (federal emission standards). The emission rate varies, of course, with type of vehicle, its age, its condition, pollution control devices, and speed.

At the present time, California standards for the principal effluents from automobiles are: 1.5 grams/mile for hydrocarbons, 2.3 grams/mile for carbon monoxide, and 1.3 grams/mile for oxides of nitrogen. However, judging from most studies of vehicle emissions, actual current average values are probably at least double these standards.

For the purposes of this study, we have assumed the most widely reported values for the current carbon monoxide output per vehicle: 50 grams/mile at a speed of 35 mph and 65 grams/mile at a speed of 15 mph. The first value has been applied to the Sir Francis Drake Blvd. traffic and the second to traffic within the development. For 1980 and later model vehicles, it is projected that these rates will drop to 8 grams/mile and 10 grams/mile, respectively.

The average source strengths (mass of CO per foot of travel distance per second) is obtained by multiplying the number of vehicles per unit time by the emission rate for an average vehicle. These figures are given in columns b and c. The total emissions from the development (values in the parentheses) were obtained by assuming a mean travel distance between entrance and parking point to be approximately 1200 ft. The total emissions from the highway (values in parentheses) are for the entire length of the highway bordering the development (approximately 2600 ft.). For purposes of comparison, the normal peak hour traffic along U.S. 101 is about 13,000 vehicles per hour, generating about 24/mg/ft/sec of carbon monoxide under 1972 conditions, or 4 mg/ft/sec under projected 1985 standards. Thus, the development's traffic during normal <u>peak</u> hours will produce a total of carbon monoxide (about 13 grams/sec) equivalent to about 1800 feet of freeway.

The peak traffic hours will occur between 6 and 9 a.m. and between 4 and 7 p.m.

The emission rates for the ferries (Table 2) are based on figures supplied by the manufacturer of the engines (Avco Lycoming of Stamford, Conn.; diesel TF 35 engine). The emission rates of carbon monoxide, oxides of nitrogen, and hydrocarbons, when the ferry is idling is equivalent to those of about 16 idling automobiles. The sulfur dioxide emission, under full power, is less than 0.2% of what an average oil-burning electric power generating plant or a petroleum refinery emits. The concentration of SO_2 leaving the stacks would be about 36 ppm when under full power and about 13 ppm when idling; the existing ambient SO_2 level is very low and even with addition of these small amounts, the air concentration should remain well below state and federal standards. The particulate emissions (.00386 grams/ft^3, according to the engine manufacturer), will be well below standards.

Table 2. Emissions from Ferries during Peak Hour Traffic.

Source	a	b	c	d
1. In terminal area, idling	15	3.8	0.32	0.7
2. On bay, full power	45	0.8	0.83	0.14

a: Total time interval, minutes, based on peak-hour of two ferries per hour.

b: Emission rate, grams/sec, of carbon monoxide. Fuel consumption assumed to be 600 lbs/hr during idling and 1560 lbs/hr at full (2500 hp) power.

c: Emission rate, grams/sec, of sulfur dioxide. Fuel consumption same as b. Based on fuel having 0.2% sulfur content.

d: Emission rate, grams/sec, of oxides of nitrogen and hydrocarbons. Fuel consumption same as b.

3. The climate of the region

The dominant factor that determines the climates of the entire San Francisco Bay Area is its proximity to the Pacific Ocean. The large scale flow of air is such that its path is almost invariably from the ocean. This maritime influence, which tempers the climate, falls off sharply with distance from the ocean and bay waters.

To illustrate, the mean monthly temperature over the Farallon Islands ranges between 51°F (January) and 55°F (October); in the city of San Francisco, the mean temperature ranges between 51°F and 62°F (Table 5); while at Hamilton Air Force Base (about 8 miles north of the Larkspur site), 46°F to 66°F (see Table 3). Thus, the annual temperature range at the Larkspur site is almost double that at San Francisco.

The hills to the west of the site play an important role in the air flow and thus the climate of the area. During the summer half of the year - May to October - when there are few storms and the flow along the Pacific coastline is almost invariably from the northwest, much of the marine air reaches the site via the Golden Gate, rather than directly from the coast. This is illustrated by the winds at Hamilton (Table 4B) and San Francisco (Table 5): In July, the dominant wind direction at San Francisco is from the west but at Hamilton Air Force Base, it is from the southeast.

Table 3. Climatological Data at San Rafael (Hamilton AFB), 1939-1970

	ANN.	JAN.	FEB.	MARCH	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
A. Monthly Mean Temperature (°F)													
Mean Max.	67.6	53.4	58.2	61.8	66.3	70.8	76.2	78.8	78.4	78.7	72.3	62.4	54.4
Mean Min.	46.1	38.7	41.4	42.4	44.5	47.8	51.3	51.9	52.0	51.5	48.2	43.4	40.1
Mean		46.2	50.0	52.3	55.5	59.4	63.8	65.5	65.3	65.2	60.4	53.0	47.4
B. Monthly Mean Rainfall (inches)													
% of days	16.0	36.3	32.3	28.3	19.4	9.7	2.6	0.3	1.6	2.8	11.6	24.3	32.9
$\overline{R}$(in)	27.54	6.55	4.57	3.13	1.84	0.40	0.19	0.00	0.04	0.17	1.64	3.43	5.58
C. Frequency of Rainfall, Fog, and Obstructions to Visibility (% of Hourly Observations)													
Precip.		15.6	12.0	9.7	5.9	2.5	1.1	0.2	0.4	0.8	3.6	9.3	14.1
Fog		29.5	16.2	4.7	3.3	2.3	0.8	1.9	2.5	3.8	7.8	17.9	30.8
Smoke &/or Haze		11.1	6.3	2.1	1.4	1.3	1.0	0.8	1.4	4.2	7.1	12.1	12.5
Obs. to vision		38.5	21.2	6.6	4.6	3.5	1.7	2.6	3.8	7.8	14.5	28.6	40.9
D. Monthly Mean Cloudiness (% of Sky Cover)													
Sky Cover (all hours)		6.0	5.7	5.0	4.5	3.9	3.0	2.0	2.5	2.4	3.5	5.0	6.3

Table 4. Prevailing Winds at San Rafael (Hamilton AFB)
(Hourly Observations, 1939-1970)

A. Annual Frequency of Wind Speeds

Speed (Knots):	Calm	1-3	4-6	7-10	11-16	17-21	22-27
% Frequency:	31.6	16.4	17.6	23.0	9.8	1.3	0.3

4B. Frequency of Wind Directions for All Hours of Day (Speed in Knots)

	Annual		January		April		July		October	
Wind Direction	Mean Speed	%	Mean Speed	%	Mean Speed	%	Mean Speed	%	Mean Speed	%
N	5.3	4.3	6.0	4.4	5.8	4.1	4.7	6.4	5.9	4.3
NNE	6.2	1.2	8.1	1.4	5.8	1.1	4.9	1.6	7.7	1.1
NE	5.3	1.4	6.5	1.3	5.4	1.1	4.7	1.8	6.0	1.2
ENE	5.8	1.0	6.0	1.3	5.3	0.6	4.4	0.7	5.1	0.6
E	6.3	4.8	6.8	5.8	4.6	2.5	5.2	3.4	4.7	3.4
ESE	6.5	3.9	6.7	4.1	5.7	2.7	6.9	4.7	5.5	4.1
SE	7.4	8.8	6.3	6.3	6.7	6.3	8.8	15.1	6.0	8.7
SSE	8.4	3.5	8.3	3.9	8.2	2.8	9.0	5.2	7.3	2.5
S	7.1	4.1	7.6	5.2	6.9	3.7	5.8	3.2	6.9	3.6
SSW	7.8	3.3	9.4	4.5	7.5	3.4	5.5	2.5	7.7	2.8
SW	6.6	4.4	7.2	4.4	6.8	5.0	5.5	3.4	6.4	3.6
WSW	7.1	2.0	8.0	2.0	7.1	2.6	6.3	1.3	7.2	1.5
W	6.5	4.9	6.6	4.2	7.6	6.9	5.5	2.8	6.1	5.0
WNW	8.7	4.9	7.9	4.2	9.7	8.0	7.9	3.0	8.1	4.6
NW	7.5	10.4	7.2	9.3	8.2	14.3	7.5	10.9	6.7	10.1
NNW	6.8	5.6	6.9	5.3	7.5	6.9	6.4	7.0	5.9	4.8
CALM	-	31.6	-	36.4	-	28.3	-	27.1	-	38.2
MEAN	4.8		4.6		5.3		5.0		4.0	

4C. Frequency of Wind Directions at 06, 07, and 08 a.m. (PST) (Speed in Knots)

Wind Direction	January		April		July		October	
	%	Speed	%	Speed	%	Speed	%	Speed
N	3.9	3.8	6.0	4.7	6.9	3.1	5.6	4.5
NNE	0.8	5.1	0.9	4.6	1.0	4.2	1.1	7.2
NE	1.8	4.8	1.4	3.6	2.3	3.4	1.2	3.5
ENE	1.5	6.8	0.5	5.8	0.6	3.6	0.2	3.1
E	8.7	7.5	1.9	3.8	3.3	3.1	1.1	5.4
ESE	2.7	8.6	0.7	5.4	2.1	3.9	0.6	6.1
SE	4.4	7.5	2.4	6.9	4.4	4.3	1.4	4.5
SSE	3.3	9.1	1.8	8.0	1.4	4.9	1.4	7.2
S	6.4	7.9	4.1	6.3	3.5	4.2	3.5	6.1
SSW	3.3	9.2	2.8	6.0	3.5	4.5	2.4	7.5
SW	4.1	7.1	3.4	5.8	5.3	4.5	2.3	4.8
WSW	1.5	7.1	1.6	5.2	2.1	4.5	0.7	4.9
W	2.7	4.6	3.7	5.0	2.8	4.9	3.6	4.0
WNW	2.2	7.0	4.4	8.4	1.9	5.7	2.3	6.0
NW	5.4	5.8	10.7	7.2	5.8	4.1	9.3	5.3
NNW	3.7	5.9	7.8	5.4	5.1	3.6	6.5	5.0
CALM	43.6		46.0		48.2		56.8	
MEAN		3.9		3.3		2.1		2.3

4D. Frequency of Wind Directions at 09, 10, and 11 a.m. (PST) (Speed in Knots)

Wind Direction	January		April		July		October	
	%	Speed	%	Speed	%	Speed	%	Speed
N	4.0	5.3	4.5	6.5	2.1	6.4	4.4	7.2
NNE	1.6	4.4	1.4	5.9	0.6	5.0	1.5	9.8
NE	2.2	5.7	1.9	4.6	1.5	4.2	2.1	7.2
ENE	2.4	6.7	1.3	4.2	1.0	4.8	1.3	5.1
E	13.1	7.1	7.0	4.6	8.5	5.6	11.1	4.3
ESE	5.5	7.0	8.2	5.4	13.9	6.4	10.7	4.8
SE	7.9	6.8	13.4	6.3	34.4	8.4	16.3	5.4
SSE	4.7	8.8	5.3	8.2	11.6	8.6	3.0	7.2
S	6.0	9.9	4.3	8.4	3.5	7.8	3.7	8.2
SSW	4.0	9.9	3.4	8.6	1.5	7.0	2.4	8.9
SW	3.3	8.0	3.6	7.8	2.1	6.3	2.6	7.1
WSW	1.4	9.0	2.1	7.1	0.9	7.3	0.9	9.0
W	1.3	7.8	5.2	8.3	2.0	7.1	2.8	7.3
WNW	1.4	7.5	5.2	9.1	2.1	8.3	2.6	8.5
NW	4.7	7.7	11.7	8.7	4.2	8.4	5.4	7.6
NNW	3.9	6.9	5.8	8.7	2.1	6.6	4.1	7.8
CALM	32.6		15.5		8.0		25.3	
MEAN		5.1		6.1		6.9		4.7

4E. Frequency of Wind Directions at 3, 4, and 5 p.m. (PST) (Speed in Knots)

Wind Direction	January		April		July		October	
	%	Speed	%	Speed	%	Speed	%	Speed
N	1.7	6.5	3.5	7.7	3.9	9.2	3.8	9.1
NNE	0.7	7.8	1.3	8.3	0.9	7.4	1.2	10.1
NE	1.8	5.4	1.0	8.3	1.0	7.5	1.2	8.8
ENE	2.1	7.3	0.8	7.7	0.4	5.6	0.6	5.8
E	15.5	7.4	2.4	4.8	3.4	7.1	3.1	5.2
ESE	7.1	6.6	2.8	5.5	7.0	7.9	4.9	5.6
SE	9.4	5.9	6.7	6.6	24.9	9.2	15.1	5.9
SSE	3.7	6.4	2.8	7.9	7.0	9.4	5.5	6.7
S	6.9	8.9	2.6	8.6	1.9	8.3	3.9	6.8
SSW	4.8	10.5	3.4	10.1	1.9	8.9	3.5	9.6
SW	5.8	7.7	6.9	9.2	3.0	9.1	5.5	8.3
WSW	1.9	8.6	4.2	9.5	1.6	9.7	2.9	7.9
W	4.5	6.8	9.7	10.6	2.5	9.0	8.7	8.9
WNW	4.0	9.2	14.0	11.5	5.9	10.5	9.5	9.4
NW	4.6	7.2	24.1	10.0	23.6	10.3	15.8	8.5
NNW	2.3	8.6	10.1	10.0	10.2	10.3	4.6	8.4
CALM	23.1		3.5		0.9		10.3	
MEAN		5.8		9.1		9.4		7.0

4F. Frequency of Wind Directions at 6, 7, and 8 p.m. (PST) (Speed in Knots)

Wind Direction	January		April		July		October	
	%	Speed	%	Speed	%	Speed	%	Speed
N	4.0	5.3	4.5	6.5	2.1	6.4	4.4	7.2
NNE	1.6	4.4	1.4	5.9	0.6	5.0	1.5	9.8
NE	2.2	5.7	1.9	4.6	1.5	4.2	2.1	7.2
ENE	2.4	6.7	1.3	4.2	1.0	4.8	1.3	5.1
E	13.1	7.1	7.0	4.6	8.5	5.6	11.1	4.3
ESE	5.5	7.0	8.2	5.4	13.9	6.4	10.7	4.8
SE	7.9	6.8	13.4	6.3	34.4	8.4	16.3	5.4
SSE	4.7	8.8	5.3	8.2	11.6	8.6	3.0	7.2
S	6.0	9.9	4.3	8.4	3.5	7.8	3.7	8.2
SSW	4.0	9.9	3.4	8.6	1.5	7.0	2.4	8.9
SW	3.3	8.0	3.6	7.8	2.1	6.3	2.6	7.1
WSW	1.4	9.0	2.1	7.1	0.9	7.3	0.9	9.0
W	1.3	7.8	5.2	8.3	2.0	7.1	2.8	7.3
WNW	1.4	7.5	5.2	9.1	2.1	8.3	2.6	8.5
NW	4.7	7.7	11.7	8.7	4.2	8.4	5.4	7.6
NNW	3.9	6.9	5.8	8.7	2.1	6.6	4.1	7.8
CALM	32.6		15.5		8.0		25.3	
MEAN		5.1		6.1		6.9		4.7

The typical daily cycle of flow in summer is as follows, which is illustrated by the wind data of Tables 4C-4F: During the morning, oceanic air surges through Golden Gate and over the San Francisco Peninsula as the land begins to warm up. When it reaches the San Francisco Bay, it splits into two streams, one heading southward and the other northward into San Pablo Bay. The northward-moving stream spreads laterally so that the wind speed is considerably reduced when the air reaches the Larkspur area from the southeast. This flow (and the southeast winds at Larkspur) increases until late afternoon then diminishes and is replaced by a weak reverse flow (NW winds at Larkspur) after nightfall.

Sometimes, marine air does penetrate the hills directly from the Pacific coastline in summer. In these cases, the direction during the day is from the northwest, reaching a peak speed in late afternoon. During the night and early morning, the wind is generally light (less than 4 or 5 mph), regardless of the circulation pattern that prevails and is usually from the northwest.

During the winter months (November to March), the daily wind cycle is not nearly as regular. When storms are approaching, the winds are typically from the SSW to SSE sector and, as the storms pass, turn to NW. There are about

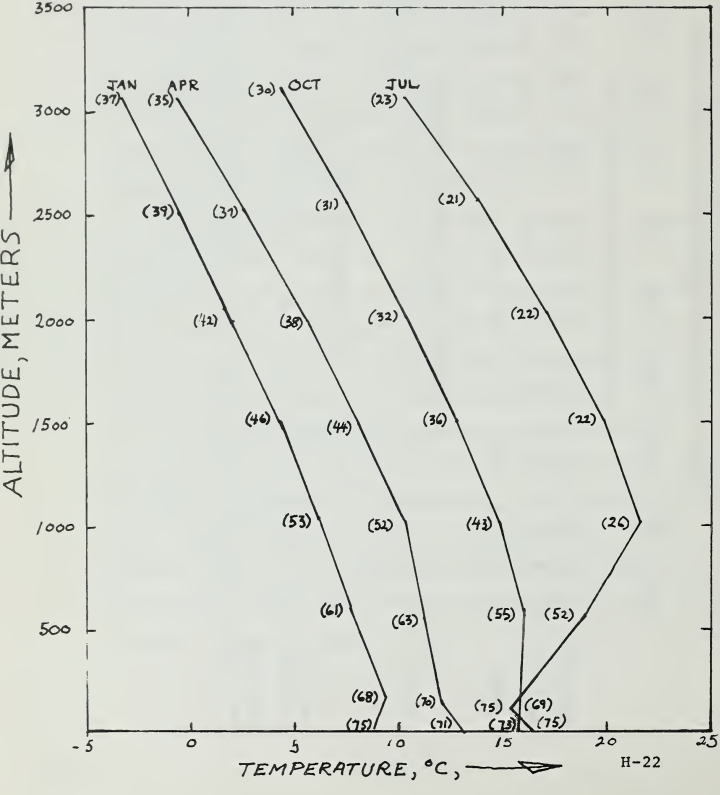
58 days per year with rain, most of which (53) occur during the November-to-April rainy season. Although the average wind speed is a little less in winter than in summer, the strongest peak speeds occur in winter during the passage of storms. Very weak winds and calm occur with a very high frequency in the fall and winter months in the intervals between storms. Thus, in winter, moderate wind speeds - associated with storms - are interspersed with periods of several days of very weak winds. Summer, in contrast, has a well-defined diurnal variation of wind speed, with comparatively-little day-to-day changes.

The high incidence of light winds (less than 3 knots) and calm (almost 50% of the time on an annual basis, see Table 4A), and the high incidence of fog and haze (Table 3C) indicate that atmospheric dispersion in this region is often quite poor. Conditions are especially poor in the Fall and Winter (October to February, inclusive). There are no vertical temperature soundings available in the immediate vicinity that might yield statistics on the depth of vertical mixing of the atmosphere. The Oakland temperature soundings (Figure 1) are not representative of the Larkspur area. It is likely that ground level temperature inversions are much more frequent at Larkspur than at Oakland because of the drainage of cold air from the hills at Larkspur.

Table 5. Climatological Data at San Francisco

	JAN.	FEB.	MARCH	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
A. Monthly Mean Temperature (°F)												
Mean Max.	55.8	58.6	60.7	61.9	63.4	65.0	64.3	64.9	68.9	68.3	63.7	57.5
Mean Min.	45.5	47.3	48.6	49.5	51.3	53.1	53.3	53.9	55.1	54.4	51.0	47.4
Mean	50.7	53.0	54.7	55.7	57.4	59.1	58.8	59.4	62.0	61.4	57.4	52.5
B. Monthly Mean Rainfall (Inches)												
Precip.	4.55	3.66	2.93	1.44	0.63	0.14	0.01	0.04	0.22	0.89	2.00	4.27
C. Prevailing Wind												
Dominant Direction:	N	W	W	W	W	W	W	W	W	W	W	N
Mean Wind Speed (mph):	6.7	7.5	8.5	9.5	10.4	10.9	11.2	10.5	9.1	7.6	6.3	6.5

Fig. 1. Mean Monthly Temperature Soundings at Oakland at 7 p.m. (PST) [1946-1955]. (Values in parentheses: Mean Relative Humidity.)



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4. Air pollution in the region

The atmospheric circulation described above plays a very important role in air pollution since it determines the rate at which man-made contaminants are dispersed. During certain periods, particularly in the Fall and Winter, the atmospheric conditions produce a high pollution potential. Table 6 summarizes the incidence of high concentrations of pollutant concentrations in two years at San Rafael (the nearest observing station) and Figure 2 gives the average monthly variation of high-hour concentrations during a four year period. As can be seen from Figure 2, the high pollution months for carbon monoxide, oxides of nitrogen, and hydrocarbons are September to March while the highs for oxidants occur between June and October. The difference in behavior between oxidants and the other species of contaminants is due to the fact that oxidants are formed from the other species and atmospheric oxygen under the action of sunlight, which is most intense during the summer. (For comparison purposes, the mean high-hour oxidant level at San Rafael is about equal to that of San Francisco, which is generally the lowest in the San Francisco Bay Area.) The other species are highest when the dispersive power of the atmosphere is least. This occurs in winter, when there are many periods of weak winds

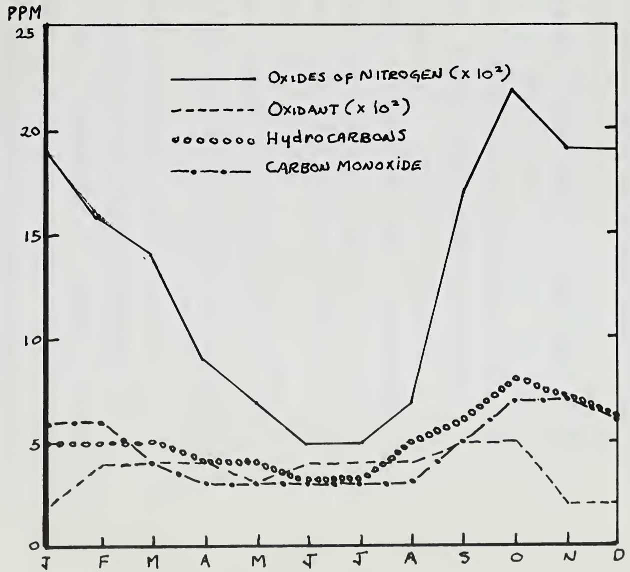
Table 6. Air Contaminant Concentrations at San Rafael

Compared with Air Quality Standards

Pollutant	Averaging Period	State Standards	Observed: No. Days Exceeded Standard In: 1970	Observed: No. Days Exceeded Standard In: 1971	Observed: Maximum Value In: 1970	Observed: Maximum Value In: 1971
Suspended Particulate	Annual* 24 hours	60 $\mu g/m^3$ 100 $\mu g/m^3$	0 4	0 6	44 136	46 $\mu g/m^3$ 125 $\mu g/m^3$
Carbon Monoxide	12 hours 1 hour	10 ppm 40 ppm	0 0	0 0	8.2 19	7.8 ppm 18 ppm
Oxidant	1 hour	0.10 ppm	41	21	0.24	0.18 ppm
Nitrogen Dioxide	1 hour	0.25 ppm	0	0	0.17	0.12 ppm
Lead	30 day	1 $\mu g/m^3$	NA	NA	NA	NA

*Geometric mean
ppm: parts per million; $\mu g/m^3$: micrograms per cubic meter
NA: not available

Fig. 2. Mean of High Hour Concentrations of Pollutants at San Rafael (Oct. 1968-Sept. 1972).



and mixing in the vertical is least due to the frequent occurrence of temperature inversions near the surface, particularly in the morning. Thus, the peak CO and NO_x concentration occurs in the winter at about 8 a.m. and between 6 and 10 p.m.; these times coincide with the peak traffic and minimum capability of the atmosphere to disperse contaminants. Oxidants, on the other hand, reach their peak concentration near midday in summer and early fall.

Existing pollution sources near the proposed Larkspur terminal site are the following: (a) rock crushing and asphalt production plant (Hutchinson); (b) route 101 traffic; (c) Sir Francis Drake Boulevard traffic. There are no figures for the emissions from the first of these. The source strengths of the latter two were given in section 3 of this report; each definitely exceeds the estimated emissions generated by the terminal.

5. Effect of proposed Larkspur terminal on climate and air pollution

The potential effects of developments on the atmosphere are of two kinds: (1) Changes in the earth's surface properties that influence the energy exchange between the surface and the atmosphere, and thus produce changes in such parameters as the air temperature and air movement. (2) Man-made emissions of heat and pollutants that can modify the climate or may be harmful and/or unpleasant in themselves.

This report will evaluate each of these effects that might result through development of the Larkspur Ferry Terminal. Each effect will be discussed in terms of the local, or "small scale" (within 4 or 5 miles of the development's border) changes to be expected as well as area-wide ("large-scale") changes.

The changed surface properties brought about by any development that may affect the atmosphere are, first of all, thermal characteristics. The atmosphere is heated (and cooled) largely through heat exchange at the earth's surface. Certain kinds of surfaces, like asphalt, heat up much more than do other surfaces, like grass or water, under the same intensity of solar radiation. Also, some surfaces, such as those of plants and water, dissipate a great deal of heat through evaporation.

Second, the surface "roughness" retards air flow. For example, the wind speed within city "canyons" is less than that over open fields, if there is no temperature difference between city and countryside.

We shall consider separately local effects - those within a few miles of the bounds of the project - and regional effects (beyond 4 or 5 miles). This is done because the diffusion of heat and pollutants in the atmosphere is such that typically the concentration of these falls off very

sharply with distance downwind of the source. Except when dealing with an especially strong source (e.g., a hot fire) or unusual meteorological conditions, the effects are typically undetectable at a distance of three or four "project lengths" (in this case, the typical length is about 1/4 mile) downwind from the project. (Although each individual project's effect may be undetectable, there is, of course, the cumulative effect of many projects. We are here concerned with only this project's impact.)

(a) Atmospheric concentrations of pollutants

The atmospheric concentration of carbon monoxide at various distances from the source can be computed from the expected source strength data of Tables 1 and 2 through application of diffusion equations. The rate of dispersion (dilution) of pollutants emanating from a source depends on such atmospheric properties as wind speed, turbulent mixing, and vertical depth of air mixing. These parameters vary greatly throughout each day and from day to day. They can be determined from surface wind measurements and vertical soundings of temperature and wind. Since there are no such data available at or even very near the site, we have had to rely on the surface wind measurements of Hamilton Air Force Base (Table 4) and Oakland soundings (Fig. 1) to obtain estimates of the dispersive power of the atmosphere in the Larkspur area.

Computation of the diffusion of contaminants requires a rather complex mathematical "model" of the source configuration and atmospheric diffusion characteristics, particularly within a mile or so of the development. However, beyond that distance we can obtain fairly accurate estimates from standard formulas.

The carbon monoxide concentration downwind from each source has been computed for the normal peak traffic hour and the normal daily average traffic, based on estimated traffic in 1975 and 1990 and on existing and projected emission rates from automobiles. The results at distances one mile or more downwind are presented in Table 7. Since the poorest dispersion is likely to occur in the early mornings of the fall or winter, extreme meteorological conditions (poor mixing) were assumed to occur during the peak traffic hours; such conditions are not likely to occur more than 25% of the time, even in these months and not more than 10% during the remainder of the year. The results show that even under extreme conditions, the effect of the Larkspur terminal traffic on the CO concentration more than a mile downwind is small. The combined effect of the terminal and the highway should not exceed 0.5 ppm at a distance of one mile in 1990 with current vehicular emissions; under such conditions, the background level would be at least

Table 7. Computed Carbon Monoxide Concentration (ppm) due to Larkspur Terminal and Other Sources in Vicinity

Source	A. Fall/Winter with severe meteorological conditions, normal peak hour traffic.				B. Annual, average meteorological conditions, normal daily traffic.			
Distance Downwind, Miles:	1	2	3	5	1	2	3	5
1. Terminal, 1975								
a. Parking	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
b. Ferries	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2. Terminal, 1990*								
a. Current vehicle emissions	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
b. Projected emission standards	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
3. Sir Francis Drake, 1975								
a. With terminal	0.2	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
b. Without terminal	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
4. Sir Francis Drake, 1990*								
a. Current vehicle emissions	0.4	0.2	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
b. Projected emission standards	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

* Automobiles and ferries.
**Includes terminal traffic.

10 ppm (the average high hour is 7 ppm, Fig. 2). Since the wind direction during severe conditions is usually from the northwest, most of the terminal's contribution would be carried toward the bay. The relative contribution of other types of contaminants should be the same, since the dominant sources (automobiles) of the development are the same types as now exist in the area.

Only rough estimates can be made of the concentration near and within the park. These are based on observations made near highways having approximately the rate of emissions as will this project. Even under severe conditions with current vehicle emissions, the contribution by the development will not exceed 1.0 ppm at a distance greater than 300 ft. from the boundary of the development or from the highway. Under normal conditions, the distance would be much less than 100 feet, if it reached 1.0 ppm at all. Within the bounds of the terminal, the concentration of CO will vary greatly from point-to-point and with atmospheric and traffic conditions. Except right on the roadways and parking lots, the concentration should never exceed 3-4 ppm (above background level) under severe conditions nor more than 1-2 ppm under normal conditions.

(b) Climatic effects

The changed concentrations of contaminants in the air (previous section) are much too small to have a detectable effect on the climate. Effects due to surface changes are likely to be ten times greater in magnitude.

The heat island effect of cities and large paved areas such as airports is now well-documented. At large paved airports in the San Francisco Bay Area, the air ia heated on the average by at least 2-3°F, and as much as 5-6°F on a clear day over surrounding areas. At the same time, the wind speed is typically 15 to 20% greater than over an adjacent city, because airports are flat with relatively-few obstructions.

In the case of the Larkspur site, the ground is hard-packed soil, flat, with very little vegetation. The change in thermal properties due to paving (parking and roadways) will be slight. The construction contemplated is generally on a northwest-to-southeast line (along the prevailing wind directions) so that they should not significantly reduce the ventilation of the parking lot and driveway areas. Considering the size of the Larkspur development and its intended use, it is unlikely to produce a temperature change of more than 1-2°F directly over it and at a distance of one mile downwind, after a typical dilution rate, with surrounding air, not more than 0.1-0.2°F. Even the slight heating produced by the paving should be largely offset by the cooling resulting from deeper water channels after dredging. Judging from the intended usages of the development,

heat generated through the burning of fuels or space heating should not affect the air temperature even over the site by more than 0.2°F.

Considering the very small heating effect of the development and the minor changes in surface roughness, there should be an insignificant effect on the atmospheric circulation.

6. Conclusions and Recommendations

(a) The Larkspur Terminal development will have an almost undetectable effect on the climate at a distance beyond a few thousand feet of the site. Within the terminal the effect will be extremely small (not more than 1-2°F warming) which should diminish to a few tenths of a degree within a thousand feet.

(b) The most serious problem is that of air pollution generation in a region where the potential for high levels of contamination is often greater. Although the contribution to air pollution by this project is small (the increment is equivalent to about that generated by 1800 ft. of highway 101) and the change in concentrations of pollutants in the vicinity barely detectable at distances beyond 1/4 mile, every effort should be made to reduce emissions. Since automobiles emit pollutants at high levels when they are

moving slowly and since the worst meteorological conditions leading to smog coincide with peak traffic, every effort should be made to expedite entrance to and exit from the parking areas. Also, the parking areas should be designed to minimize air stagnation.

(c) The primary advantage of a site at San Quentin rather than at Larkspur is that the wind speed is likely to be somewhat higher at the former. This would give somewhat better dispersion of air contaminants.

(d) It is recommended that an effort should be made to study the environmental changes brought about by this project so that future developments could be planned with data on hand. It is suggested that an air sampling station be established on the site for at least a year (six months before operation of the terminal and six months following its opening). Observations of wind, temperature, and air pollutants should be made.

Appendix I

Traffic Impact Report

July 2, 1973

by

JHK & Associates
San Francisco, California

jhk & associates

James H. Kell, president

July 2, 1973

Mr. Frank C. Boerger
Madrone Associates
33 Mitchell Boulevard
San Rafael, California 94902

Attention: Mrs. Phyllis M. Faber

Subject: Traffic Impact of a Larkspur Ferryboat Terminal

Dear Mr. Boerger:

This traffic impact report has been prepared to assist you in the development of an environmental impact report for the proposed Larkspur ferry terminal in Marin County. We have identified the important positive and negative traffic impacts of a terminal as well as the relative impacts between alternative sites.

Positive Impact

Positive impacts include those to both the potential user and non-user. As with BART in the East Bay, and the Southern Pacific Railway on the Peninsula, ferry service offers the North Bay an alternative to highway travel. Whether or not the commuter avails himself of the service, he has the opportunity to choose an alternative mode of transportation which is potentially less damaging to the environment. Even for those who do elect to use the service, there is an advantage which can be measured by the vehicle miles of highway travel removed from streets and highways.

Several estimates of commuter patronage for a central Marin ferry service are available. The estimates range from a high of 8,500 riders per day based on attitude survey methods to 3,200 per day (for 1975) based on empirical methods. Since the empirical methodology was used to accurately forecast ridership on the Sausalito ferry prior to its operation, it was determined to be a logical method to use for this report. It is anticipated that the terminal will be used by non-commuters as well as commuters, but patronage estimates for this type of patronage are not available. However, since traffic impact is most marked during commute periods, the lack of this information will not significantly change the conclusions drawn from this report.

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A survey of the Sausalito ferryboat users in 1970 found that 2/3*of the riders were former auto users and 1/3* were former bus users. Applying these proportions to the Larkspur service, 2100 of the 3200 daily commuters would be diverted from autos. With 1.3 persons per auto, 1600 autos will be removed from Highway 101 between central Marin and downtown San Francisco. The roundtrip distance savings will be approximately 30 miles, or 48,000 vehicle-miles of travel per day. If after 1975, additional ferries are operated, these figures would of course increase.

Negative Impact

The establishment of a ferry system will result in some negative environmental impact in the vicinity of the terminal site, since a node of concentrated highway traffic will be produced by passengers arriving and departing by auto and bus. The presently planned terminal site is in an area of light traffic generation. However, it is expected that adjacent land east of Highway 101 will be the site of a major commercial/office center. On Sir Francis Drake Blvd. immediately west of Highway 101, a major regional shopping center is proposed. Even without the ferry terminal these developments would radically change the character of the area and heavily load adjacent Sir Francis Drake Blvd., Highway 101 and the interchange. In addition to these loads, the ferry terminal will generate ferry feeder bus and auto traffic, surging with the arrival and departure of ferryboats at half hour intervals.

The impact of this future local traffic was comprehensively analyzed in a report by the Marin County Balanced Transportation program. Titled "Central Marin Ferry Terminal Traffic Impact Analysis," the report related the ferry feeder commute travel to the arrival and departure of the individual ferries. As quoted in the excerpt which follows, the 1,400 passengers per hour figure is comparable to the 3,200 daily commuters referred to in this report:

> IMMEDIATE IMPACT - 1975
>
> The use of the terminal is projected to be concentrated at commute hours on weekdays. It is the very high peaking which makes the impact significant. Current proposals call for two 750 passenger ferries landing in the peak one hour.

*Current estimates indicate potentially higher diversion from buses.

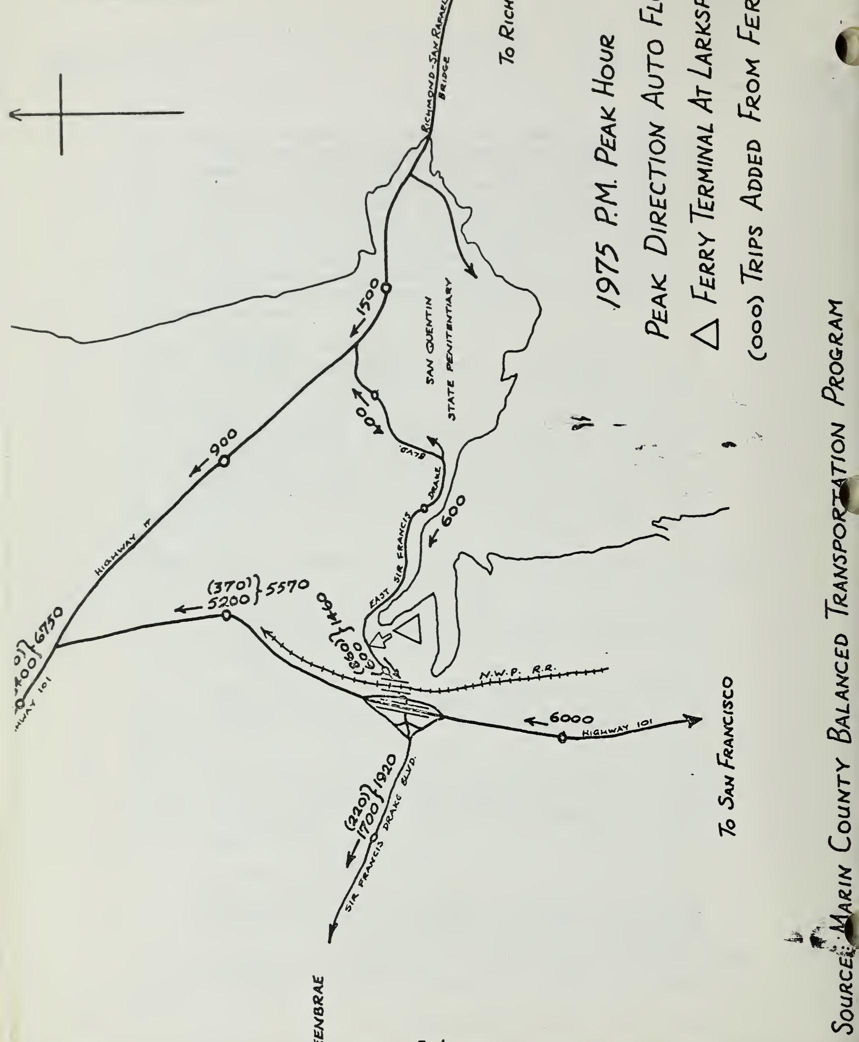
> It will be assumed that these two boats will deliver 1,400 passengers per peak hour and that 20%*of these patrons will use bus, bike or their own footpower to leave from the terminal in the evening rush hour. Because none of the sites is within walking distances of but a handful of homes and in that a 1,200 car parking area will be provided, a large portion of users are projected to arrive by car. This large portion, about 80% of total passengers, will either drive their own car or be picked up at the terminal by another car with an overall average occupancy of 1.3 passengers per auto. This means about 860 cars will attempt to depart from the terminal site at the peak hour in 1975.
>
> Some traffic will also be arriving at the terminal and will cause an additional amount of congestion by conflicting with departing and through traffic. Arriving traffic will be travelers using the off-peak direction ferry service along with those drivers arriving to pick-up commuters from San Francisco.

Exhibit 1 shows the 1975 traffic assignments from the Marin BTP report. The report continues:

> The Larkspur site being adjacent to the Route 101 Freeway concentrates the ferry terminal impact along a very short stretch of East Sir Francis Drake Boulevard and at the Greenbrae freeway interchange. The total 1975 peak hour traffic, 1460 cars, could not be accommodated on one lane and widening of the route would be needed.
>
> Further compounding the situation is the fact that all ferry terminal traffic will have to leave the parking area by making a left turn across eastbound Sir Francis Drake traffic. A traffic control device would appear to be needed to allow the parking lot to empty.
>
> The existing railroad trestle is a constraint which must be modified when the terminal opens to avoid additional congestion.

*Note, this is an assumption for comparison purposes only.

EXHIBIT 1


1975 P.M. Peak Hour
Peak Direction Auto Flows
△ Ferry Terminal At Larkspur
(000) Trips Added From Ferry
Source: Marin County Balanced Transportation Program
To Richmond
Richmond-San Rafael Bridge
San Quentin State Penitentiary
1500
900
Highway 17
100
600
East Sir Francis Drake Blvd.
(370)
5200
5570
6750
Highway 101
N.W.P. R.R.
6000
To San Francisco
(220)
1700
1920
Sir Francis Drake Blvd.
Greenbrae

Because the parking area will be located very near the freeway interchange, there will be relatively little opportunity for the concentrated traffic congestion to disperse. The problem may be sufficient to affect the operation of the interchange itself.

Access to the parking area in the morning peak period will probably cause less congestion but turning movements in the existing Greenbrae interchange from San Rafael to the terminal will have to cross westbound Sir Francis Drake traffic causing some congestion. Some northbound Route 101 traffic destined to the ferry terminal will further add to congestion at the merge point near the trestle.

FUTURE YEAR IMPACT - 1990

The projected future peak hour use of the Central Marin Ferry Terminal is based on assuming three boats*will arrive in the peak hour delivering 2,200*passengers to the terminal. These passengers will drive 1,300 cars from the terminal assuming higher uses of bus and bike by 1990.

The traffic volumes on East Sir Francis Drake Boulevard are projected to grow by a factor of 4 due to development other than the ferry terminal. These very high traffic volumes are due to intensive development proposals on the San Quentin Peninsula, the Larkspur/Corte Madera area, and the southeast corner of San Rafael. Considerable growth in traffic is also projected to and from the East Bay which adds to the volumes on East Sir Francis Drake Boulevard. These proposed developments would cause traffic volumes which would require a very high standard four lane road even without the ferry terminal.

The Larkspur site again suffers due to its location at the hub of a very congested freeway interchange. Adding the ferry terminal traffic

*Hypothetical, not an actual projection.

to the projected volumes for 1990 yields a peak hour volume of 4,000 cars. This volume would require at least three peak direction lanes or complete recontstruction of bast Sir Francis Drake Boulevard to a four lane full freeway with direct connections via a four level interchange with Route 101. Access to and from the terminal parking lot would be complicated by its location immediately adjacent to the freeway interchange.

The 1990 traffic volume map from the Marin BTP report is shown in Exhibit 2. The depicted traffic volumes are based on countywide traffic model studies by the BTP and reflect conservative development assumptions in the vicinity of the terminal site. Rather than the now proposed regional shopping center, a medium-sized center in Bon Air was assumed, and the assumed San Quentin Peninsula development level was less than plans now approved. Nonetheless, the projected traffic volume on West Sir Francis Drake Blvd. is more than double the existing volume even without the ferry terminal.

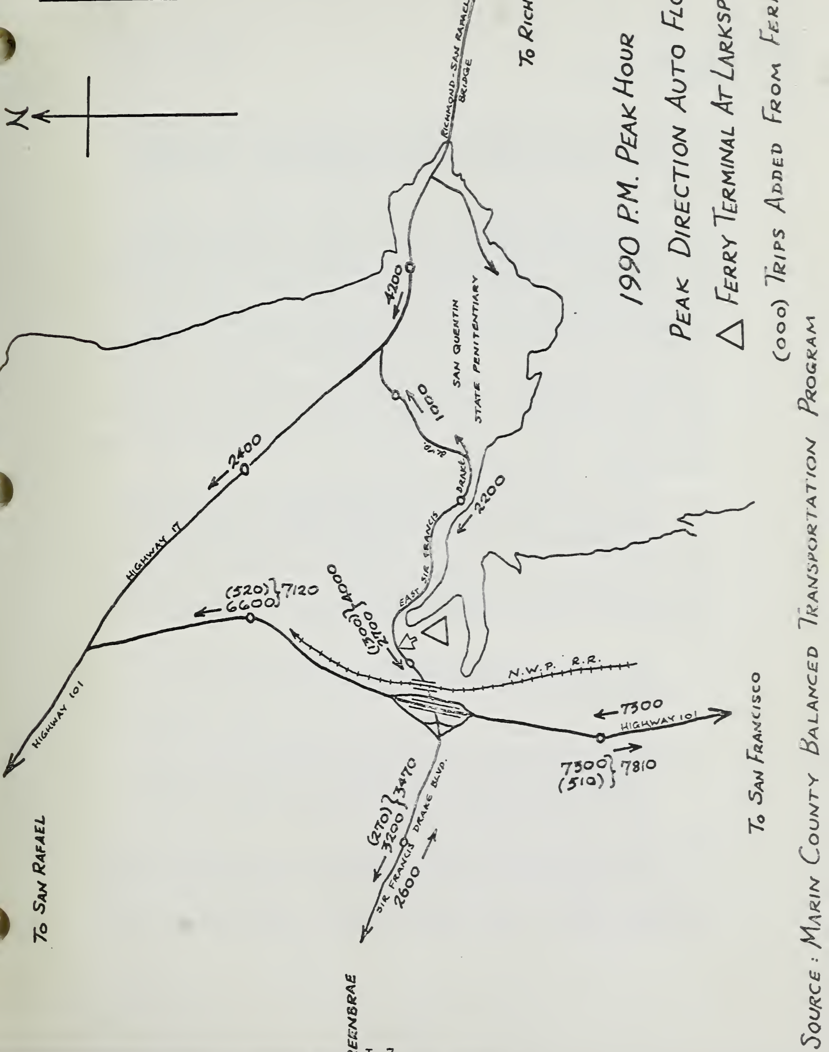
East of Highway 101, the traffic demands produced by the combined developments will require widening of East Sir Francis Drake Blvd. from two to six or more traffic lanes. Eventually these developments may create pressures for construction of a north-south arterial at, or east of, the existing railway line. As stated in the BTP report, the interchange would also require modification if all proposed nearby developments occur.

Alternatives

There are two types of alternatives which would change the positive and negative traffic impacts associated with a Larkspur ferry terminal. One is no terminal nor service, and the second is an alternative site.

As to the no-service alternative, the trade-off to be considered is between operating the cars 15 miles to San Francisco against concentrating 1½ lanes of feeder traffic (one-way 1975) at the terminal site. This infers, also, a

EXHIBIT 2


1990 P.M. PEAK HOUR
PEAK DIRECTION AUTO FLOWS
△ FERRY TERMINAL AT LARKSPUR
(000) TRIPS ADDED FROM FERRY
SOURCE: MARIN COUNTY BALANCED TRANSPORTATION PROGRAM
N
TO RICHMOND
RICHMOND-SAN RAFAEL BRIDGE
SAN QUENTIN STATE PENITENTIARY
4200
1000
2400
HIGHWAY 17
2200
DRAKE BLVD.
EAST SIR FRANCIS
(520) 6600 7120
(1300) 2700 4000
N.W.P. R.R.
HIGHWAY 101
7300
7300 (510) 7810
TO SAN FRANCISCO
TO SAN RAFAEL
(270) 3200 3470
SIR FRANCIS DRAKE BLVD.
2600
GREENBRAE

comparison of 1½ lanes of traffic on San Francisco streets with 1½ lanes of traffic in the vicinity of the Larkspur terminal. From a traffic impact standpoint, the removal of 15 miles of traffic is obviously the preferred alternative.

There may be alternative terminal sites which would offer less negative impact. Two alternative sites are now being considered. One is south of the approach to the Richmond-San Rafael Bridge (San Quentin Village) and the other is north of the Bridge approach. Recent patronage projections based on the empirical method have projected considerably less ferryboat usage at these sites as compared to the Larkspur site. These projections, based on a preliminary analysis by Kaiser Engineers, indicate that patronage at the south site would be 53%, and at the north site 71%,* of that at Larkspur. The patronage reductions relative to Larkspur were found to be due primarily to the greater land access distance of the terminals from the residential areas served.

Thus, for the alternative sites, both positive and negative traffic impacts would be reduced due to less patronage. Regarding additional negative impact differences, the Marin BTP impact report concluded that the south site would create fewer localized traffic problems than the Larkspur site even if patronage were equal. This finding, quoted below, would generally be true for the north site as well:

> This site offers the greatest traffic benefit and the least requirements for highway facility expansion.
>
> Access to Route 17 would have to be expanded but this could be quite minor depending on the exact location of the parking area. Current use of the existing interchange and freeway is sufficiently light that only minor modifications would be needed to serve ferry terminal traffic.
>
> East Sir Francis Drake Boulevard would not have to be widened to four lanes although congestion at the

*Without direct access from Route 17, this would be 47%.

Greenbrae interchange would be somewhat greater than currently exists.

Access to this site in the morning peak would be more direct for San Rafael and Upper Ross Valley patrons via Highway 17 than it would be to the Larkspur site. The latter requiring a difficult left turn at the Greenbrae interchange.

The traffic to and from this site would, however, change the quiet character of the San Quentin Village during peak hours.

The 1990 volumes of ferry traffic combined with a more intensive use of Highway 17 would require modification of the existing interchange at San Quentin Point.

This site would provide some reduction in the impact of the ferry terminal but non-ferry traffic volumes are so large the requirements along East Sir Francis Drake Boulevard and at the Greenbrae interchange are nearly as great as with the Larkspur terminal.

Highway 17 has sufficient capacity to handle the projected volumes except as noted at the San Quentin Point Interchange.

A ferry terminal at San Quentin East would have relatively small impact when compared to the very large non-ferry travel demands projected for this area.

San Quentin Village could not exist as it now does should the ferry terminal be located nearby. The village would take on the character of a "Sausalito" rather than a sleepy waterfront town.

The report then concluded that, compared to the south site, the Larkspur site would have greater negative traffic impact. Undoubtedly, had the north site been studied, it too would have been found preferable to Larkspur. Since this conclusion was reached prior to the finding that the

Larkspur site would stimulate greater patronage, it is not known what the recommendation would have been under those circumstances.

In conclusion, JHK finds that the positive traffic impacts produced by a Central Marin terminal clearly outweigh negative traffic impact. It was also found that the Larkspur site is adjacent to an area with a greater potential for traffic congestion than are the alternate sites. However, considering the Larkspur site's potential for diversion of more of the 15-mile San Francisco commute trips, the Larkspur site may be the most desirable from a total traffic impact perspective.

Yours truly,

Donald K. Goodrich

Donald K. Goodrich
Senior Transportation Engineer

DKG:ns

PRELIMINARY EVALUATION OF SHOALING AT THE LARKSPUR FERRY TERMINAL

Prepared for Harding, Miller, Lawson, & Associates

by

R. B. Krone

Davis, California
November 27, 1972

PRELIMINARY EVALUATION OF SHOALING AT THE LARKSPUR FERRY TERMINAL

Shoaling in channels and mooring basins created by excavation of bed material is a significant problem in the San Francisco Bay system. Parts of harbors, such as the Martinez Marina, have been made useless by shoaling rates that could not economically be compensated by dredging. Many harbors, such as Bel Marin Keys, Coyote Point Marina, and Palo Alto Yacht Harbor, have found the expense of dredging onerous. These maintenance costs will be multiplied in the future if present restrictions on the disposal of dredged spoil are enforced. Design of the harbor for minimum shoaling and investigation of probable rates of shoaling for alternate designs are appropriate early efforts.

Sediments near the Larkspur Site

Sediment materials in the shallow areas of the west side of San Francisco Bay are composed largely of clay and silt sized minerals with fine sand found in stream channels where the slope first diminishes. Most of the materials are composed of 40 to 60 percent clay sized minerals. These are very small particles that are generally platy with irregular edges and have negative charges on their faces. These physical characteristics determine the behavior of sediment material in the estuary as described below.

The bulk properties of fresh deposits include low bulk densities of around 25 pounds of dry material per cubic foot of deposit and shear strengths that are weak for structural considerations but sufficient to resist typical shear stresses imposed by tidal flows and to firmly hold a ship that runs aground.

The sediments originate from soils eroded in the drainage basins contiguous to the San Francisco Bay system. More than 80 percent originate in the central valleys and the remainder are from local drainage basins such as that drained by Petaluma Creek. Eroded particles are carried in suspension by fresh water flows where the very small sizes of the individual mineral particles, and the consequent very low settling velocities, cause their

movement to be nearly identical to that of the flowing water. During high flows the water is visibly muddy.

Most of the material enters the Bay system with rainfall and snowmelt runoff during winter and early spring months. During unusually high fresh water discharges a portion flows through the system over the more dense salt water intruding from the ocean and out through the Golden Gate. Under more common fresh water discharges, however, the stream waters mix with ocean waters in the estuary. When ocean waters have mixed with the fresh waters to the extent of one part or more ocean water to 32 parts river water the clouds of excess cations, relative to their abundance in solution, attracted by the negative mineral face charges mentioned above are sufficiently compressed that particles can approach each other closely without the mutual repulsion that otherwise resulted when the clouds of ions intermingle. A universal short range force then causes such particles to cohere. Hydraulic conditions in the fresh and salt water mixing zone cause repeated collisions of suspended cohesive particles, and aggregates having very much increased settling velocities are formed there. The increased settling velocities, together with very much lower currents in the broad expanses of shallow bays, cause most of the material carried to the Bay by entering streams to be deposited initially in these shallow areas.

Daily onshore breezes occur in the Bay region during spring and summer months because of the air rising over the hot interior valleys. These breezes generate waves in unsheltered shallow areas that resuspend material deposited there and keep it in suspension while even slow tidal currents circulate the sediment throughout the system and gradually transport much if not all of the annual supply out to the Pacific Ocean.

Suspended sediment is available for the formation of shoals throughout most of the winter, spring, and summer months. About 4 million tons of new material enter the Bay system each year, and it is deposited and resuspended and circulated many times during the year. The natural bed configuration adjusts so that the rate of resuspension by wind generated waves or by currents equals the rate of deposition. Modifications of the bed that reduce the rate of resuspension will result in shoaling unless the

supply of suspended materials is also reduced. Excavation of a stable mud area at Benicia for a wharf approach resulted in a 17 foot deposit in three months!

Marshlands are shallow areas that are stabilized against erosion by encroaching plants.

Sediment Transportation near the Larkspur Site

Strong ebb currents flow through San Pablo Straits, and these currents are responsible for the configuration of the main channel extending from the Straits down around Angel Island and out the Golden Gate. Contours of this channel are shown on the Coast & Geodetic Survey Chart 5532. The water depths on the west side of the channel up to the depth 6 ft. MLLW are determined almost entirely by bed shear stress from tidal currents. At lesser depths, however, the bed configuration is determined increasingly by the intensity of wind generated waves.

Winds measured at Hamilton Air Force Base are presented in Figure 1. The frequency of moderate and high winds shown in Figure 1 are greatest for those from the northwest and southeast. Hamilton AFB is more open than the shallow area near the proposed terminal site, and the winds are relatively unaffected by the hills.

The northwest-southeast wind direction is shown by arrows marked on aerial photographs presented in Figure 2. Bottom surface contours are also plotted in Figure 2. The arrows show that the prevailing winds are nearly parallel to the north shore of the area. The bottom contours are roughly perpendicular to the direction of the prevailing winds. The wide spacing of the contours shows that the bottom has a very gradual slope, which is typical of areas where the depths are determined by waves generated within the area.

Winds apply shear to the water surface, which is one of the forces that generates waves. This shear stress also drives water at the surface downwind. A wind set-up, or superelevation, of the water surface develops near the downwind shore and return currents along side shores where wind velocities are less or at lower depths in the water results. Winds and the resulting wave action are less along the side shores. This distribution

of velocities across the direction of the prevailing wind is responsible for the curvature of the contours shown in Figure 2.

The ridge along the south side of the channel is partly due to wind distributions but more probably it is due to dredge spoil placed there and spread by waves and currents. It could also have been formed from coarser material carried down Corte Madera Creek during unusual storm runoffs. The relative importance of these causes was not determined.

Current directions are determined by winds, when winds occur, and by tides. Data on tidal currents is not available. From the contours it would be expected that flood currents in the shallow area are from the south south-east and ebb flows are toward the southeast. Ebb flows in the channel are probably down-channel at low water and spread across the ridge during times of higher water. Flood flows would generally be in opposite directions. Because sediment is suspended at high concentrations during windy periods, however, the important currents are those that occur during such times.

Selection of an Approach Channel

An approach channel design can be selected for minimum shoaling by finding those that have a combination of the lowest rate of deposition and the highest rate of scouring. Scouring velocities in an access channel having the cross section proposed (300 feet bottom width, 12 feet below MLLW depth, and side slopes of 1:6) would require confining walls along the channel and a large body of open water upstream from the harbor in an arrangement similar to that at Bel Marin Keys. Shoaling would occur in the large body of water,but the approach channel would be self maintained. A model study would be required to determine the area of water surface required. In view of environmental and land value considerations, however, such an arrangement does not appear feasible and was not considered further.

In the absence of means for significantly increasing flood and ebb currents in the access channel, and thereby keeping suspended material in motion, there remains the strategies of minimizing the concentration of suspended sediment materials in water entering the channel and minimizing hydraulic conditions that promote aggregation. As described above, sediment

concentrations are high in the shallow area during frequent wind periods. A barrier preventing the entry of water from the shallow area to the channel is desirable. A dike or wall confining the existing channel or dikes confining a channel across the mud flats from the harbor out to the -6 ft. MLLW contour would allow entry of water from the main channel which has much lower concentrations of suspended material. The channel boundaries can be made to curve gradually and to eliminate protrusions or sudden irregularities that would cause eddies in the flow.

The advantages of the existing channel compared to any other channel across the shallow area are:

1. The existing channel follows the shortest path from the proposed terminal site to deep water. Both the amount of material to be dredged and the length of a dike, if installed, would be minimized.

2. One side of the channel is already confined, and the height of a dike on the south side would be slightly less than that along any other path.

3. Minimum construction dredging would be required along the path of the existing channel.

The existing channel appears to be clearly advantageous from the standpoint of shoaling. If the full 300 ft. width is essential, about half of the cross section is now available.

Estimates of Shoaling Rates

Shoaling rates were calculated for the terminal basin and for the approach channel assuming a 6 foot range of tide, an average channel depth of 15 feet, a strength of flood and ebb current of 0.15 ft/sec, and assuming that the material behaves as does that in upper San Pablo Bay and Mare Island Strait. The results were as follows:

Entrance Channel	Average Suspended Sediment Concentration, mg/l	Average Shoaling Rate, ft/yr	
		Channel	Harbor
Unwalled	500	1.2	1.3
Walled	100	0.2	0.1

These calculations indicate the very large effect of suspended sediment concentration on shoaling rates and the benefit of allowing only clearer water from the main channel to enter the approach channel.

The distribution of shoaling will be affected by bends and irregularities in the channel boundaries. The straightest, most uniform channel will have the lowest and most uniform shoaling. The channel will shoal fastest at the edges and upstream and downstream from disturbances to the flow such as piers or moored barges.

These shoaling rates are to be considered preliminary. The state of present knowledge limits the accuracy of such estimates, and variations in currents and suspended sediment concentrations from those assumed can cause significant fluctuations in shoaling rates. Model and field studies will be very desirable to refine these estimates if this project is to be undertaken. The values for the unwalled channel are not very different from those indicated by the sketchy data provided in Figure 2 and year 1968 post-dredging surveys.

Over 10,000 linear feet of wall will be required to confine the channel. Any barrier to flows from the mud flats will suffice, provided that the barrier has no openings along its length. The mud has little bearing strength and a heavy structure will require a pile or sand key foundation. A treated wooden wall supported on piles should be considered. Alternatively, a dike constructed from material excavated by a clamshell during enlargement of the channel can be effective if it is maintained to compensate subsidence and erosion by wave action.

Harbor Configuration

The mooring area at the terminal should consist of a simple enlargement of the spur channel to the minimum width necessary for operating the ferries conveniently. Side slips and finger piers should be avoided, and an enlargement to provide turning space should include gradual transitions of channel width. From the standpoint of shoaling, use of the Corte Madera Creek junction for turning would be preferable to construction of a widened turning area. These conditions will minimize both the rate of deposition in the harbor and the area of harbor to be maintained.

Waste discharges to harbor waters should be eliminated to avoid aesthetic deterioration of the terminal

Conclusions

This preliminary study revealed several factors that are important to evaluation and design of the proposed Corte Madera Creek ferry terminal:

1. The exposure of the shallow mud flat area to prevailing winds indicates that it can supply water having high concentrations of suspended sediment to a channel crossing the shallow area and to the proposed terminal site during much of the year.

2. The existing channel of Corte Madera Creek follows the shortest path across the shallow area and is already bounded on one side by the north shore.

3. Estimates of shoaling rates, using typical concentrations of suspended sediment for such waters, indicate very significant differences in shoaling rates for confined and unconfined channels.

It is therefore recommended that:

A. A uniform, smooth, gently curving or straight channel along the present Corte Madera Creek exit alignment be designed.

B. The harbor consist of a uniform enlargement of the existing spur channel with a minimum of irregularities and with smooth transitions.

C. Costs of maintaining an entrance channel along the present creek alignment with and without the wall be ascertained.

D. Costs of alternate wall construction be estimated and compared with benefits indicated by C.

E. If the minimum cost indicated by C & D indicate that the project is feasible, further model and field studies be conducted to confirm the estimates and to refine the channel design, particularly the extent of the wall toward deep water, if the wall option

is selected. Field observations should include measurements of currents, stage, and suspended solids. Physical model studies should be used to determine current patterns, and mathematical model studies should be made to determine effects of wind on water movements.

Approximate costs of such studies based on costs of similar studies, are:

Field studies	$ 6,000
Physical Model	5,000
Math Model	10.000
TOTAL	$21,000

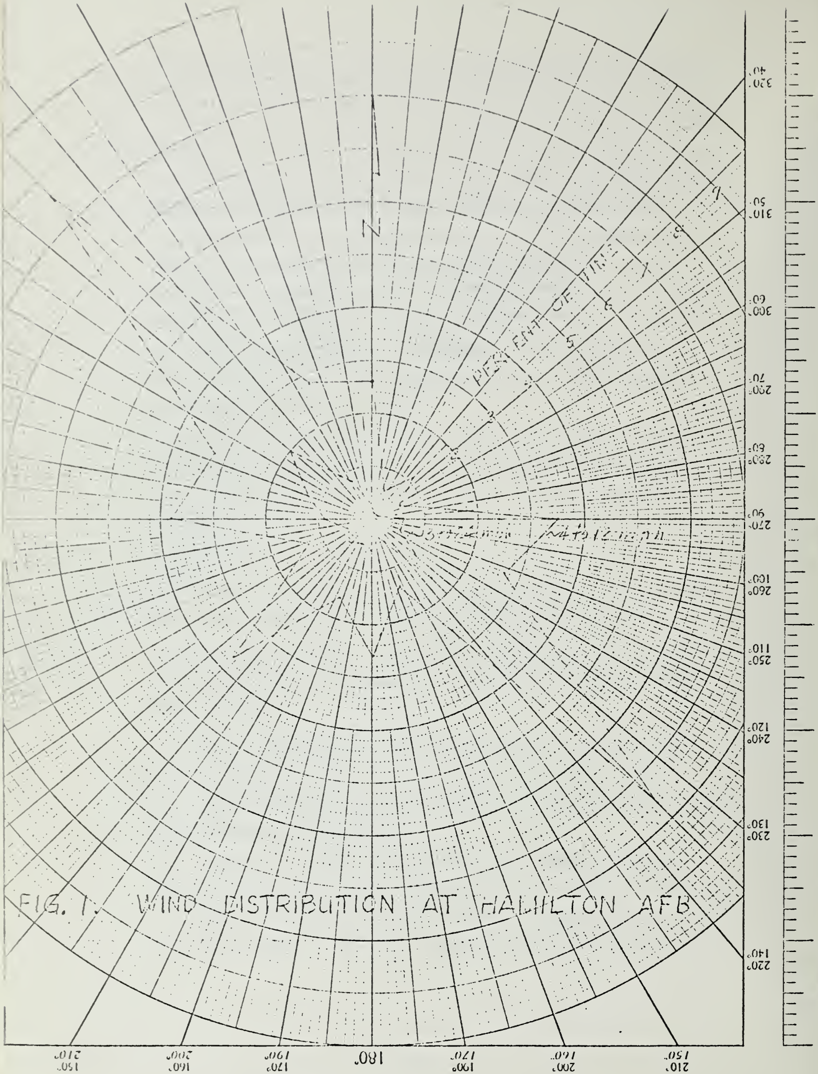


FIG. 1. WIND DISTRIBUTION AT HAMILTON AFB

Appendix K

IMPACTS OF LARKSPUR FERRY TERMINAL PARKING FACILITY ON WATER

July 6, 1973

TO: MADRONE ASSOCIATES

FROM: BROWN & CALDWELL, CONSULTING ENGINEERS

SUBJECT: IMPACTS OF LARKSPUR FERRY TERMINAL PARKING FACILITY ON WATER

Impacts of Proposed Facilities

The provision and use of the proposed parking facility is expected to have the following impacts on water:

1. The peak flow rate and amount of storm water that enters offshore waters by surface runoff from the site will be increased because of curtailed contact with soil at the site. Peak flow rates of storm water runoff from the site of the parking area are expected to be increased approximately as shown in the following table.

Average Time Between Occurrences of Stated Peak Flow Rates	Estimated Peak Flow Rates (cubic feet per second)		Estimated Increase In Peak Flow (cubic feet per second)
	Without Project	With Project	
2 years	1	15	14
10 years	3	30	27
100 years	5	45	40

2. Materials will be imparted to storm waters which are not now imparted at the site, including the following:

    (a) Petroleum derivatives from fuel, lubricants and hydraulic fluids leaked from vehicles. A thin film of oil will form at the point of entry of runoff to quiescent receiving waters, as will be evidenced by appearance of a sheen.

(b) Compounds of lead, nickel and zinc, arising principally from leakages of fuel, lubricants and hydraulic fluids. Zinc will also arise to a very small extent from material worn from tires.

(c) Fine particles worn from tires and clutch and brake linings.

(d) Dirt, rust, and decomposing coatings from fender linings and undercarriages.

(e) Vehicle components broken by vibration or impact (glass, plastic, metals, etc.)

(f) Asphalt and various products of decomposition of asphalt.

(g) Constituents of paints used on the surface of pavement.

(h) Particles of rock used as aggregate in the pavement.

(i) Litter discarded by users of the parking area.

3. Materials now imparted to storm waters will be imparted to storm waters at the site in greater or lesser amounts, depending on the regularity of cleaning of the parking area, the method of cleaning, and the method of disposal of materials removed from the area. Proper disposal of sweepings to land will prevent entry of sweepings to surface waters, whereas washing of accumulated materials into drains will transfer those materials into surface waters.

Shown in Columns 1 and 2 of the following table are daily rates of accumulation of materials considered in this analysis to substantially exceed the highest rates that could be expected at the site after development and use for parking; the values are based on data obtained through analysis of materials accumulated on streets in San Jose, California, where traffic and other activities are much higher than will occur at the site.(1) Data representing parking areas with the low traffic and activity expected for

Constituent	Column 1 Dry Weather Rate of Accumulation lb/day/acre	Column 2 Daily Accumulation in Dry Weather pounds	Column 3 5-day Accumulation pounds	Column 4 Concentration of 5-day Accumulation in 0.1 Inch Runoff mg/l
Soluble and colloidal solids	0.08	1	5	20
Insoluble non-colloidal solids	1.6	22	110	400
Volatile solids[1]	0.17	2.3	12	40
Biochemical oxygen demand (5-day)	0.04	0.54	3	10
Chemical oxygen demand	0.79	11	55	200
Nitrogen[2]	0.005	0.07	0.4	1
Phosphate[3]	0.002	0.02	0.1	0.3
Chromium	0.0005	0.007	0.03	0.1
Copper	0.0012	0.016	0.08	0.3
Zinc	0.0036	0.049	0.2	0.7
Nickel	0.00033	0.0045	0.02	0.07
Mercury	0.00073	0.01	0.05	0.2
Lead	0.0046	0.062	0.3	1
Cadmium	0.00007	0.001	0.005	0.02

(1) Materials which are essentially organic.
(2) Nitrogen concentrations over 2 mg/l in phosporus-rich receiving waters can support excess growth of algae.
(3) Receiving waters are naturally rich in phosphate.

the proposed project are not now available. Shown in Column 3 are amounts of materials which would accumulate in five days in an area the size of the proposed parking lot, given the unexpected high rates of accumulation shown in Column 2; five days is the assumed length of time between sweepings. Data obtained in San Francisco indicate that a 0.1 inch rainfall can flush most of the accumulated bulk of such materials from a paved surface.[4] Column 4 shows the hypothetical concentrations of materials which would occur in storm water runoff before dilution with other waters, for the case in which amounts shown in Column 3 are imparted to runoff from a storm that produces only 0.1 inch of runoff. The values shown in the table while far exceeding those which can occur with the proposed project, nevertheless provide some perspective from presently available data.

Mitigation Measures - On-Site Storm Water Runoff

Materials will be imparted to storm runoff at the site in amounts directly proportional to the amount of time that elapses between the most recent of days in which the site was properly cleaned or in which a rainfall approximating or exceeding 0.1 inch occurred, and the next day in which either such event occurs. Available measures which can limit the amount of materials discharged from the site to offshore waters are proper cleaning of the pavement surface and treatment of runoff preceding discharge to offshore waters. Runoff can also be conveyed by pipeline to points in offshore waters which offer greater immediate dilution than that available near the shoreline.

Shown in the following table are typical efficiencies of removal of accumulated materials by well maintained and well adjusted street sweepers.[1]

Constituent	Percent Removal Per Pass Of Street Sweeper
Total Solids	55
Biochemical Oxygen Demand	43
Chemical Oxygen Demand	31
Nitrogen	44
Phosphate	22
Total Heavy Metals	50

Dry weather construction activity of the proposed facilities is not expected to substantially affect water except for raising a minor amount of dust which will fall into offshore waters. The generation of air-borne dust at all areas undergoing excavation, grading, filling or cutting or at areas subject to other dust-producing activities by vehicles can be limited by application of liquid palliatives, water, or penetrating asphaltic materials.

If construction extends into the rainy season, runoff from unprotected soil surfaces that have been loosened during construction could carry soil into offshore waters, causing substantial turbidity in those waters. The construction specifications should stipulate that the contractor should expose the least area of land subject to erosion that is practical at any one time during the rainy season. The specifications can also require construction of

sediment basins to precipitate silt from storm runoff before it leaves the site, and can require use of plastic sheets on surfaces susceptible to erosion.

Specifications will require contractors to provide sufficient safeguards and to use construction techniques that will give adequate protection to offshore waters from accidental spillage and waste of materials directly into water courses or into areas where such materials would eventually be carried to water courses by storm runoff. Potential sources of such pollution, which are readily subject to control, are the following:

1. Sanitary waste
2. Spillage of fuels, grease, oil, etc.
3. Waste from equipment washing
4. Spillage of asphalt and other bituminous materials
5. Trash

Alternatives

Alternatives include not providing parking facilities, providing a parking lot near the rod and gun club, and providing a roofed parking structure in San Quentin Village. Those alternatives are discussed below.

No Parking Facilities

If no parking facilities are provided, existing conditions of hydrology and relationship to quality of storm water runoff at the proposed site will remain as is until the site is altered or

developed for other purposes. Alternative uses of land that involve covering soil with pavement or buildings will change hydrology in a manner similar to that discussed in Item 1 in the preceding section titled "Impacts of Proposed Facilities." Alternative land uses that involve passage of vehicular traffic or storage of vehicles in open areas will have impacts similar to those discussed in Items 2 and 3 of that section.

Provide Lot Near Rod and Gun Club

This alternative would have impacts similar to those discussed above under the title "Impacts of Proposed Facilities."

Provide Roofed Parking Structure in San Quentin Village

Storm runoff would not contact the floor upon which cars are parked, unless cars are parked on the roof of the structure. For the case wherein cars are parked on the roof, impacts would be similar in type to those discussed above under the title "Impacts of Proposed Facilities," and estimated rates of accumulation of materials would be one-fifth of those which would occur with the proposed open parking lot; concentrations of those materials in runoff would be equal to those occurring with the proposed open parking lot. For the case wherein no cars are parked on the roof, it is expected that storm water would not receive any appreciable amount of metals or petroleum derivatives, and would receive other material in amounts substantially lower than the amounts that would be received if cars were parked on the roof.

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Appendix L

PRELIMINARY PLAN FOR LAND DISPOSAL DREDGING SPOILS

A preliminary plan for land disposal of dreding spoils from the Larkspur Ferry Terminal is proposed for use in marshland reclamation on the Muzzi property.

Sediments dredged from San Francisco Bay which exceed the limits for heavy metals set by the San Francisco Regional Water Quality Board must be disposed of on land or in the Pacific Ocean at the 100-fathom line.

Analyses of the sediments to be dredged for the Larkspur Ferry Terminal show that sediments from the harbor area (Coring Stations 1 - 6) exceed the RWQCB limits for heavy metals. The estimated volume of these spoils is 390,000 cubic yards. The sediments from the channel area, approximately 910,000 cubic yards, meet the standards for disposal in San Francisco Bay near Alcatraz.

Ocean disposal currently increases the cost of dredging approximately \$1.65 per cubic yard over the cost for adjacent land disposal, a total of \$644,500 in this case. Land disposal sites are limited in the San Francisco Bay area. Consequently, much consideration is being given by the U. S. Army Corps of Engineers to the use of dredging spoils for the building and restoration of salt marshes.[1,2]

In Corte Madera Bay, a 255-acre diked-off marsh, known as the Muzzi property, is under consideration as a land disposal site for the dredging spoils from the Larkspur Ferry Terminal site (see Area Map, Figure 1). Spoils would be distributed, using interior dikes, in such a way as to provide a 40-acre building site for the present owner and a 26-acre site for future use by the Bridge District in connection with the development of a rapid transit system. The

remaining 188 acres would be restored to viable salt marsh by raising elevations to those required for growth of salt marsh plants and opening the dikes to expose the marsh to tidal action.

Restoration of salt marshes and mud flats is highly desirable, since only 25% of those which surrounded San Francisco Bay 100 years ago remain today.[3] Successful salt marsh restoration has been accomplished in East Palo Alto, California, on a 95-acre parcel known as the "Faber Tract." The restoration of this marsh is described in a memo attached to this report (p. L-6), prepared for Madrone Associates by Dr. H. Thomas Harvey, a professor of Natural Science at California State University, San Jose, and a consultant to the Bay Conservation and Development Commission and to the U. S. Army Corps of Engineers on the ecology of San Francisco Bay and the Bay marshes. Dr. Harvey directed the marsh restoration activities which have resulted in a viable salt marsh on the Faber Tract only two years after the breaching of the dike around the marsh. Madrone Associates' staff inspected this marsh in early June 1973, and can testify to its healthy state.

Preliminary investigation of the Muzzi property was conducted by Madrone Associates in December 1972, as part of a biological assessment of the Corte Madera Redevelopment Project Area No. 1.[4] In order to plan for the restoration of the 188-acre marsh, further investigations have been carried out.

The primary factor controlling the establishment of salt marsh vegetation, once tidal action is restored, is the elevation of the tidal flat above mean lower low water (MLLW).[5] Since MLLW varies around San Francisco Bay, ranging from -1.1 feet Mean Sea Level (MSL)

(1929 datum) to -4.5 feet MSL[6], it was deemed necessary to determine elevations of local salt marsh vegetation in order to insure the deposition of spoils to final levels suitable for growth of salt marsh plants.

Preliminary elevation determinations on the Muzzi property (January 17, 1973) indicated that the marsh had subsided to levels ranging from +1.2 feet MSL to +2.9 feet MSL at points along the bay side of the property behind the dike.[4] Earlier elevations shown on the 1966 Bay Toll Crossing Map, 1929 MSL datum, showed an elevation of +1.4 feet MSL for a bay front portion of the Muzzi property behind the dike (consistent with the Januar 1973 determinations) and elevations of +2.5 feet MSL to +4.0 feet MSL for the adjacent Heerdt Marsh, which has never been diked off from tidal action and which is covered with healthy salt marsh vegetation.

On the basis of these preliminary elevations, it can be estimated that the total amount of spoils (1,300,000 cubic yards) from the ferry project can be disposed of on the Muzzi property, providing approximately 66 acres of building site and 188 acres of marsh.

The two main plants colonizing salt marshes in Corte Madera Bay are cord grass (Spartina foliosa)and pickleweed (Salicornia virginica). As shown in Figures 2 and 3, cord grass grows in the project vicinity from -0.5 feet MSL to +2.9 feet MSL. Pickleweed grows from +0.2 feet MSL to +4.6 feet MSL. (The average range for pickleweed was noted to be from +2.0 feet MSL to +3.6 feet MSL.)

Madrone Associates biologists and engineers will monitor the spoils disposal process. Once the spoils become stabilized at the required elevations, marsh plants will be transplanted from adjacent marshes to speed up the establishment of the salt marsh.

The possibility of the release of mercury into the surround waters once the dikes are opened and the spoils area is subjected to tidal action, has been considered. Referring to spoils disposal in water, Dr. Robert C. Cooper, Associate Professor of Environmental Health Science, University of California, Berkeley, has stated:

> It cannot be assumed that all mercury present in spoil will be released to the water column when spoil is discharged. There is good reason to believe that much, if not all, the material present will remain firmly attached to various forms of particulate matter and will be merely relocated in the general Bay sediment.

No effect of the mercury upon the growth of marsh plants in the restoration area is anticipated because marsh plants are currently thriving in the area from which the spoils will be obtained, and because marsh plants have reestablished themselves in the area within the Muzzi property where spoils were deposited in 1967-68 from Corte Madera Creek.

Dr. H. Thomas Harvey visited the Muzzi property on June 5, 1973, with Madrone Associates' staff. On the basis of his experience and research on marsh restoration, he concurs that the regeneration of the Muzzi marsh is highly feasible.[8]

MEMO

June 14, 1973

To: Mrs. R. Kingsley

From: Dr. H. Thomas Harvey

Re: Faber Tract

The "Faber tract" of approximately 95 acres originally was tidal marsh; it was diked off in the 1930s (est) for a hay field. Sometime in the late 1950s the dike broke and tidal water again affected the tract. In 1968 the Public Works Dept. of Santa Clara County requested apermit from BCDC to dump about 200,000 cubic yards of spoils from dredging the Palo Alto yacht harbor. In the permit they agreed to open the dikes to tidal action after the spoils had stabilized.

The dredging was completed in May 1969 and the dikes could have been opened in November of that year but only after considerable pressure the dike was breached on July 15, 1971. During the two years without tidal water a sparse cover of mainly perennial pickleweed became established. In the lower northwest side a relatively permanent body of water, that was maintained by pipes at the northwest corner, encouraged a relative dense growth including annual pickleweed. However, in the major portion of the area the perennial pickleweed density was only about five plants per acre.

Seven days after the dike was opened on the 22 of July 440 cord grass plants were planted in three transects from south to north. The purpose of this planting was to determine what was the limiting factor or factors to cord grass growth at the higher elevations. Although not all factors have been examined, the amount of soil moisture seems to be the critical factor. I interpret this to be determined by the frequency of the highest tide. The upper or higher plantings (5 or 6 plants in each transect) died and a few intermittently along the transects. At present about 250 plants (60%) are still alive and have spread to cover about 100 square meters. Some individual plants have spread to cover over 2 square meters in about a year and a half since the planting. Those at the lower elevations apparently are growing best.

The cover of pickleweed now seems to be close to 60% of the area, and during the winter the open areas between plants are covered with algae so that the area is verdant throughout the year. Preliminary study of the quality of water going into the tract and then out with the changing tide is that water quality is improved.

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HISTORICAL AND ARCHAEOLOGICAL SURVEY OF THE PROPOSED FERRY TERMINAL AT POINT SAN QUENTIN, CALIFORNIA

Elizabeth B. Goerke

June 1973

Submitted to:

Madrone Associates
35 Mitchell Blvd.
San Rafael, Calif.

Location and Description of Project

Two sites have been selected as possible ferry terminal locations on Point San Quentin. One of these sites is situated in the village of San Quentin; the other is to be found north of Route 17 and west of the Marin Rod and Gun Club (see 3 and 4 on Map 1). This report will concentrate on the archaeological and historical record of the eastern San Quentin area.

Archaeological and Historical Background

This area is rich in Indian and early Marin County lore. The Indian inhabitants were known as the Coast Miwoks, and although the History of Marin (Munro-Fraser) describes them in 1880 as nomadic, they actually lived in semipermanent villages, utilizing their environment to the fullest (Kroeber and Kelly).

There is a known archaeological site (4-Mrn-79) recorded by Nelson in 1907 and located approximately near the conjunction of Route 17 and Sir Francis Drake Boulevard. This shell midden has never been properly explored and was partially destroyed when Sir Francis Drake was widened in the 1950's. No artifacts have been located which could be used to date the site.

That Point San Quentin was frequented by Indians has been documented by Mexican and American travelers and settlers. General Mariano G. Vallejo reported that in 1824 two Mexican officers pursued Chief Marin to Estero de San Rafael (San Rafael canal) but gave up the chase when they encountered a group of Indians gathered on rafts there. His men then continued along the shore to Punta de Quintin, where they found Marin's subchief, Quintin, who was subsequently taken into custody. After the capture of Quintin the area became known as Punta de Quintin but was later changed to Punta de San Quentin, according to Vallejo, by newcomers who felt that "the inhabitants were zealous Catholics and, desiring to gain their good will, added San (Saint) before the towns or villages they visited" (Munro-Fraser).

An early resident of Marin, Daniel Taylor, reported that when he arrived in the Bay Area in 1849 he saw "wigwams" on a rancheria where the prison hog yard was later located (Taylor). In the 1860's C. D. Bates, a contractor, used material from Indian shellmounds in the area to construct the San Rafael-San Quentin road (Meret). Apparently no Environmental Impact Reports were required in the 1860's. An article in the

Marin Journal of December 30, 1860 mentioned that in building the turnpike an "Indian rancheria of great depth was excavated near San Quentin. Fifteen or sixteen Indian skulls were removed. One was said to be that of Chief Marin, but antiquarians found it to be too small" (Meret).

This area is of great interest to those historians who would like to prove that San Francisco Bay, and particularly the area near this peninsula, could have been the location for the landfall of Sir Francis Drake in 1579 (Aker, Powers, Treganza). With the fourth centennial celebration of Drake's visit, this area will be in the news.

In 1840 Punta de Quintin was given to Juan B. R. Cooper, the husband of General Vallejo's sister, by Governor Juan B. Alvarado in payment for a debt. The land grant, some two square leagues, included the peninsula and the major part of Ross Valley. This area was very difficult to survey because of the dense growth of oaks and giant redwoods. Early accounts also report abundant wildlife which included elk, deer and bear, as well as flocks of waterfowl so dense they blackened the sky (Lauff). In 1830 over 100 otters had been spotted in San Quentin Bay (Ogden).

J. B. R. Cooper spent little time on his property other than building a house on the point and erecting a sawmill. He hired a foreman to look after the cattle and supervise the Indians who raised vegetables and fruit.

In 1850 the rancho was sold to Benjamin Rush Buckelew for $55,000. A few years later, hearing that a state legislative committee was coming to the area to look over a possible prison site, Mr. Buckelew invited the committee to his home for dinner and was repaid for his hospitality by having his property chosen. He received $10,000 for 20 acres where the prison stands today. Mr. Buckelew had put up a hotel on a dramatic bluff in the area (see Shepard Hotel, Figure 2). When he died at an early age, his widow, Martha Buckelew, decided to build a ferry terminal on Agnes Island (where the present San Rafael Bridge enters Marin County). This necessitated a causeway from Point San Quentin to the island, as well as a wharf, both of which were constructed in 1860 (see Figure 2). This ferry landing became the chief terminal for San Rafael-San Francisco travelers and commuters. The travelers continuing to San Rafael took a stagecoach from Buckelew's hotel, known as the Shepard Hotel. At that time it was an hour's ride over a winding road (Kneiss). This trip was shortened in 1865 when a "turnpike" was constructed across the marshes from Point San Quentin to San Rafael. This is the road that used Indian

shellmound material for fill. As a result of the new road, steamer fares were reduced from $2.00 to $1.00 (Dickinson).

In 1869 the commuters held a meeting to discuss the possibility of a railroad from the ferry terminal to San Rafael. As a result of this meeting San Rafael, with a population of only 700 in 1870, had its own railroad to Point San Quentin, and Mrs. Buckelew's ferry terminal became the chief route from San Francisco to the Marin County seat. Dickinson reports, however, that in 1884 Sausalito was made the main terminal.

The Shepard Hotel was sold in 1867 to Jack McRae, which brings us up-to-date, since his grandchildren are living in the Bay Area today and were willing to share what they could remember of life in San Quentin Village at the turn of the century.

Surveying Plan and Results

San Quentin Village was walked to determine whether there are any extant Indian mounds. A broken pestle in association with deer bones had been uncovered in the garden of 2 Main Street a year ago. The soil was made up of broken shell for a depth of one foot, underlain by an inch of sand and then red dirt. The backyard next door at 1 Main Street had just been overturned for a garden, but the owner stated that all the shell in the soil had been placed there purposefully by his wife. Although the soil at 2 Main Street was full of shell, the soil underneath the porch as well as underneath the foundation (the house is raised off the ground) did not look like Indian midden. There were no surface indications of Indian remains in San Quentin Village, however there is always the possibility of finding subsurface cultural material. No renter, owner or early resident contacted remembered ever hearing about or seeing any Indian artifacts in the village.

In speaking with the children and grandchildren of early settlers in the area, some interesting history of the village came to light. Mr. Jack McRae, who bought Mr. Buckelew's Shepard Hotel, was the first postmaster. The second postmaster was his daughter, who married Frank Mails and subsequently a Mr. Newby. Liquor was sold at the hotel until prohibition. However, after prohibition was repealed, the bar could not reopen because a California State law prohibited the sale of liquor near prison grounds.

Mrs. Newby assumed her duties as postmaster only under Democratic administrations. Whenever the Republicans were in office she relinquished her job to a Mr. Kenny, just across Main Street.

Mrs. Newby turned the hotel into apartments and lived in the house at 38 Main Street. Her son, Walter Mails, was a well-known baseball star from 1914 to 1936. (All information on Mrs. Newby: personal communication from her children, Margaret Mails Landers and Walter Mails.)

There was a second hotel operating in the village at the turn of the century under the ownership of Mr. LeCount, who bought the property from Mrs. Pennie (see Map 2). Both the LeCount and the Pennie families have streets named after them in the village. The picturesque old brick hotel is still standing on Main Street, but it is no longer occupied. The old grey house at 95 Main Street had originally been a grocery store, and in the rear of this property was one of the five saloons reported at San Quentin in the early 1900's (Grace Duffy Zubler).

One of the most famous families of the village, the Duffy's came to San Quentin in 1895. Grace Duffy Zubler reported that her family lived first in the house at 21 McKenzie and moved by 1902 to the charming house next door on the corner of McKenzie and Main Street. Her brother, Quentin Duffy, was the warden at San Quentin from 1940 to 1951.

The age of the existing houses was determined by old maps (see Map 2, 3) and a 1950 assessor's commission estimate of the age of individual houses (see Map 4). Many of the houses in the village were built before 1900. The old Shepard Hotel, built in 1851, was torn down in the 1960's. According to the assessor's report, the oldest existing structure is a white house at 16 Main Street with an estimated date of 1865. Another house on that same parcel was thought to have been built in 1880. (See Map 4 for dates and addresses.)

Recommendations

The proposed ferry site north of Route 17 is on filled marshland, so there should be no impact even if Route 17 is widened at the area of the proposed terminal.

Although there were no surface indications of Indian habitation in San Quentin Village, there is the possibility that in the course of constructing the ferry parking area Indian artifacts could be revealed with subsurface excavation. If this is the case, an archaeologist must be consulted immediately. After inspection, the archaeologist would either suggest recovery of the material within a reasonable amount of time or plan for the preservation of the area. Archaeologists today are paying greater attention to preservation, even if it means paving over an area. Decisions for salvage or preservation can be determined only by an archaeologist.

If the village is chosen, at least 12 pre-1890 houses would be destroyed, including the oldest extant house built in approximately 1865. The charming house at the corner of McKenzie and Main Street in which the Duffy's lived would be threatened if not destroyed. Since this area is so rich in early Marin history there should be some thought given to saving the picturesque village. Houses could not be saved piecemeal according to the architect's drawing (see Map 5), since all houses between Main Street and Pennie Terrace west of McKenzie Street would be leveled for the ferry parking area.

Artists still come to the area to sketch Marin as it used to be. This village could be saved by designating it, or at least some of the houses, as a State Historical Landmark or by placing it on the National Registry.

LEGEND FOR MAP 4

Assessor's Estimated Age	Assessor's Block No.	Assessor's Parcel No.	Present Address
1900 (At least 1895 - Grace Duffy Zubler)	162 -	05	21 McKenzie
1900 (Possibly older)	162 -	06	100 Main St.
1888	162 -	08	4 Main St.
1888	162 -	10	1 Main St.
1888	162 -	11	2 Main St.
1888	162 -	12	3 Main St.
1868	163 -	01	22 McKenzie
1900	163 -	02	95 Main St.
1883	163 -	05	LeCount Drive
1888	163 -	06	LeCount Drive
1870	163 -	10	10 Main St.
1865, 1880 (Two houses)	163 -	11	16 Main St.
1878	163 -	14	97 Main St.
1883 (Old brick hotel)	163 -	20	-
1878	"	"	22, 24 Main St.
1890	"	"	18, 18-A, 20, 20-A Main St
1884	164 -	01	-
1880	164 -	04	38 Main St.

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APPENDIX N

Letter from R.K. Procunier
to Hon. Peter H. Behr

May 15, 1973

STATE OF CALIFORNIA—HEALTH AND WELFARE AGENCY RONALD REAGAN, *Governor*

DEPARTMENT OF CORRECTIONS
SACRAMENTO

May 15, 1973

Honorable Peter H. Behr
Senator, Fourth District
State Capitol
Sacramento, California

Dear Senator:

This will answer your letter of May 10th concerning the proposed use of San Quentin property as a ferry terminal.

In view of the latest developments in the department resulting in increased population and the reactivation of some housing units at San Quentin, I cannot, in good faith, encourage the proposal to utilize the property in question for the ferry site in the immediate or foreseeable future.

Since the Golden Gate Bridge District has expended some time and energy in reviewing this site, I would have no objection to making whatever is needed available to them to complete their study since in long-range planning it might some day be possible.

Sincerely yours,

R. K. Procunier
Director of Corrections

Enclosures - Letter and Map

cc: Warden L. S. Nelson, San Quentin